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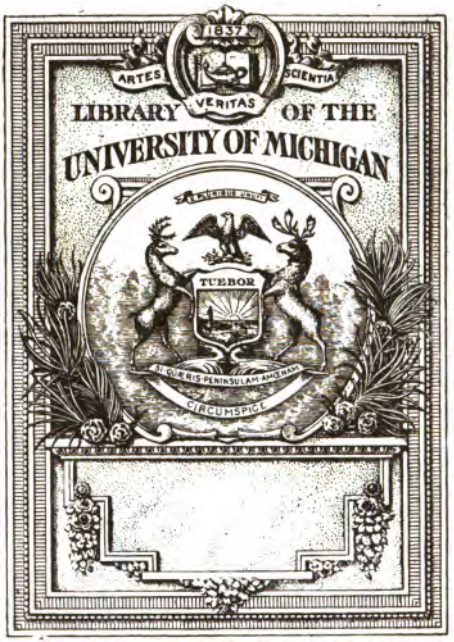

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THE

MODUS OPERANDI

OF THE

CELL FORMATION

OF

ANIMAL AND VEGETABLE LIFE,

BY

ELIZA A. BURNHAM.

DEC 1 1916

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023 Fly

TO THE SCIENTIFIC WORLD,

WHOSE FAITHFUL LABORS IN MATHEMATICS, PHILOSOPHY, BOTANY, ANATOMY, PHYSIOLOGY, CHEMISTRY AND ASTRONOMY HAVE ENABLED ME THROUGH THE DATA, WHICH THEY HAVE FURNISHED, TO MAKE THE DISCOVERIES CONTAINED IN THIS WORK, THIS VOLUME IS MOST GRATEFULLY AND AFFECTIONATELY INSCRIBED.

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1716

PREFACE.

1. I have aimed, in treating Vegetable Cell Formation, to touch all points where I thought that one versed in structural botany might find difficulty in comprehending the mode of the cell formation.

2. In treating of Animal Cell Formation, for a variety of reasons, I have thought proper only to illustrate the general principles of Cell Formation and show causes of perfect and imperfect development.

3 One of these reasons is, that no amount of illustration on this subject would render it more comprehensive to one who is ignorant of anatomy; and one who understands it will need no further illustration on the subject. Neither have I deemed it necessary to make observations on the forms of cells produced by pressure and tension, or on the additions or filling up of cells after they are formed, either in the Animal or Vegetable economy; nor have I thought it necessary to give an exposition of any except the typical blossom as others could be understood by their analogy with the perfect flower; or to speak of Endogens or Cryptogamia, they being, in general, Parenchyma.

4. As the effects of heat would be the same, whatever might be its cause, I have judged it an uncalled for exposition to mention the different views of philosophers on the subject.

5. As this work calls for an understanding of the circulation of the blood, and as such a great variety of theories exist on the subject, I have not deemed it necessary to make an apology for setting forth my views and course of reasoning on the subject.

INTRODUCTION.

1. The thesis which is presented in these essays, is one in which I am so perfectly sanguine as not to entertain doubt; and I am equally so in regard to its infinite value—its great practical utility in human life and health.

2. Every individual who places before the public a theory on any subject, has reason to expect criticism, and they meet that which is a thousand times more to be feared than the sternest criticism, and that is, prejudice in favor of pre-conceived opinions; haply, however, I do not know that there are any particular views existing on the subject of cell formation. I have searched books, in vain, for assistance.

3. These things being so, that is my willingness to encounter the danger in offering this production to the public, gives to me a just claim to respectful consideration. By respectful consideration, I do not mean that these views are not to be investigated to the very last degree—facts are sacred things—they should be sacrificed to the caprice of no individual; but what I do mean by respectful consideration is, that if these views are attacked, I wish that it may be done in candor, and by valid argument, instead of noisy words, that might be received by persons not capacitated to judge, and thus act, indirectly, at least, deleterious to my welfare and subvert the benefit which others might derive from the work.

4. I should be deeply pained if I thought this subject, in which I believe every human being to be vitally interested, was not to be investigated.

5. The idea that I should be found incorrect in any view set forth in these essays, would weigh nothing in my mind when compared with the advantages which I should derive by being set right.

6. In this, as in all other works of this character, persons not familiar with sciences are liable to meet with terms which they do not understand; but the great and important facts, on which so much of human happiness or misery depends, can be comprehended by any ordinary intellect.

PART I.

VEGETABLE CELL FORMATION.

CHAPTER 1.

Preliminary Remarks.

1. Botanists are well acquainted with the fact that all the different organs required to form vegetable existences are composed of cell structure, from the most perfectly developed exogen, down to the most simple of thalogens, whether radicle, stem, leaf, blossom or fruit, all are cells.

2. Anatomists are equally well acquainted with the fact that every organ required in any animal existence is likewise composed of cells, from the most perfectly organized human being down to the most simple of zoophytes, whether belonging to the nervous, muscular or bony system, all are cells.

3. Now does there exist some analogy between Animal and Vegetable life? Are they derived from the same law? *Is* it of any importance to know anything on the subject?

4. Certain it is, that if all animal organs are composed of cells, and if these cells are continually passing away and forming anew, that should they continue to form as perfectly as at first, the function, of the system would remain, essentially unchanged.

5. What! soliloquises one; can it be possible, that an essayist in the nineteenth century, can presume so much, and even attempt dragging us back to the visionary days of Ponce de Leon, and sending us in search of a wonderful fountain?

6. Nothing of that kind is contemplated. Blind, indeed, must be that understanding which is incapable of perceiving the utter futility in expecting that any one of common intelligence, in this age of the world, could receive a theory, not having for its data, principles susceptible of demonstration.

7. I do hope that no one will get the idea that I design to teach the doctrine that people will never die, if they obey the laws of health. I have said nothing of the kind, nor do I design to say anything of that character; but I do feel bound to assert, in the most unequivocal manner, my firm belief that if we knew the manner in which these cells are formed, we should be better prepared to understand the causes that would tend to their perfect or imperfect development, and, consequently, be more capable of judging, under any given circumstances, whether we were acting wisely or unwisely.

8. Now, to obtain the most perfectly satisfactory views on the subject, requires no great mental effort, nor long continued application; it requires, simply, to be able to cemprehend, and follow out in their bearings, a few obvious principles that have already been demonstrated by patiently persevering, scientific men.

CHAPTER II.

Agents of Vegetable Cell Formation.

1. As the Vegetable Economy is so much more simple than the Animal, and, therefore, more easily understood, I deem it advisable to expose that first, and then take the analogy, if we find any to exist, as a kind of stepping-stone to our researches in the Animal Kingdom.

2. The most ordinary observer does not fail to notice the fact that heat and moisture, as well as air and a genial soil, are requisite to develop or grow vegetation.

3. The effects of a drought in shrivelling and drying up vegetation, is so obvious that there exists no two opinions on the subject.

4. And, again, when we have plenty of moisture, but a cold atmosphere, how common the observation, that it is so cold that nothing can grow; and we see little increase in size while this state of things exists.

5. The Physical Geographer tells us that these principles hold good over the whole surface of the earth; for instance, in the region of the great Amazon, with its many broad tributaries flowing over and irrigating the soil of Equatorial Regions, a region, fanned, also, by moist breezes from the Atlantic, Pacific and Caribbean, there is found the most dense vegetation on the globe—heavy forests, thickly grown underwood, and woven together with vines forming jungles, which wild beasts can scarcely penetrate.

6. The gigantic forests of California rear their lofty heads to say, we stand in latitude 35; we are sheltered on our north-east by ranges of the great Rocky Chain, and we sip the nectar from the Equatorial Pacific,

wafted to our lips by returning trades and currents.

7. And every extraordinary vegetable production can tell its own peculiar story of its eligible position for development. Deserts say they have no moisture, and Arctic Regions tell us they have little heat; and thus it is that every locality, over the entire surface of the ball, describes its climate, as well as its soil, in the character of the vegetation, which it produces.

8. But how is this heat, moisture, air and elements of the soil used to grow or develop vegetation? Why does it make its accessions in cells, dividing one into two, and placing one on the top or under another? There must be a reason for these phenomena, otherwise, here is an effect without a cause—a notion not very popular in the present age of the world.

CHAPTER III.

Principles of Vegetable Cell Formation.

1. Before entering upon this illustration, I beg leave to present a few principles, which will be needed in the exposition of the subject that we may not be weak in argument when arriving at those points of the discussion, which will call for their use.

2. Now, these principles are the very same to which I alluded, when I said that they had already been demonstrated by scientific men; therefore, I hope that suitable attention will be given them as they are brought to view; although we may be well acquainted with them, yet, it may not be amiss to be reminded of them, in order, that we may fully appreciate their bearings under all circumstances.

3. These principles are three in number; namely,

The power of heat in evaporation, the pressure of the atmosphere and the nature of a vacuum.

4. First, the power of heat in evaporation. It is not necessary, in order to show this power, to state the results of experiments showing how much water has been carried off from a given surface in a certain time.

5. It is sufficient to allude to the every-day experience of any individual; for instance, a lady hangs out her clothes to dry in a damp atmosphere; sun being excluded—they hang three days and are as wet as when first put out; she places them in a dry atmosphere, and the action of the sun dries them in two hours.

6. A lady mops a room, in which there is no fire; she leaves the doors and windows closed, and it is not dry in a week; she mops one, in which she has a fire, and it is dry in two hours.

7 The generation of steam from all moist surfaces, leaves no possible doubt, that this element, which we call heat, caloric, electricity, fine element, ether in motion, and many other names, does actually enter between the particles, of which water is composed, and separating it, thus rendering it lighter than air, and so carrying it off.

8. There is no chance for two opinions on the fore going view; it admits but one, and that is the following: The moment that heat has access to moisture, it commences evaporation, and continues to act, unless withdrawn, until it has exhausted the last particle; and would, were not moisture re-supplied, soon sweep every vegetable as well as animal existence from the surface of the earth.

9. Second, the pressure of the atmosphere is to be considered; this is found to be about equal to fifteen pounds on every square inch of surface, to which it

has access, whether that surface lies up, down or perpendicular.

10. There can be no uncertainty relative to the influence of this power, it being instantaneous in its action, the moment a vacuum is formed by heat or any other cause, that moment it steps in and fills the place.

11. I do not mean that it always has precisely the same force, because there is a variation of about one pound on the inch, having but fourteen sometimes; but with the power which it possesses, it is ever ready, and never fails to perform the part expected from its weight, and that underground as well as above, and in all cavities of bodies, to which it has access.

12. Third, we are to notice the nature of a vacuum; in the common acceptation of that term, a vacuum is space, from which nearly all the air has been withdrawn or exhausted; but the air being out, is not evidence that caloric is not in, it being so subtle as to enter all bodies, on which it can act with its natural force; its most formidable barrier, a cake of ice, it takes down in a short time.

CHAPTER IV.

Exposition of Vegetable Cell Formation.

1. Prepared with the foregoing principles, we will enter upon the exposition of the Cell Formation of Vegetable Life.

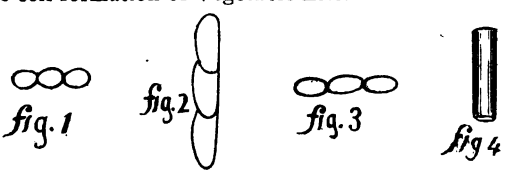
2. This illustration, I have deemed expedient to divide into two parts; namely, formation of the cells, and the power that carries the moisture and elements of the soil to such extraordinary heights as they sometimes go.

3. First, the formation of the cells; this subject will be most conveniently treated by sub-dividing into six parts; namely, cells of stems, cells of roots, cytoblast, spores, blossoms and seeds.

4. It might appear to some to be more in order to commence with the seed; but I have thought it convenient to treat cell formation first, and then show how the embryo plant grows as the seed forms.

5. First, cells of stems are to be considered; these, by authors, are classed under four heads; namely, Parenchyma, or spheroidal cells, Pleurenchyma, or lapped cells, Trachenchyma, or cells blended into a tube and Cienchyma, or vessels used for deposit, transportation, and air.

6. It is known that the pressure of the atmosphere, will sustain a column of water in a vacuum, over thirty feet in height; and with this knowledge, we will content ourselves until we arrive at the second part of the cell formation of Vegetable Life.



7. We will commence our exposition with the Parenchyma, Fig. 1, it being the most simple, and found in all vegetable substances. Suppose a column of these cells to exist, being under thirty feet in height; we are to show, first, how a new cell can be formed on the top of this column; and second, how this cell which is at the top at first, can be divided into two, and consequently, how any lower cells may be divided.

7. As the atmosphere presses on the ground, and in every cavity under-ground, it would, were there nothing in the way, enter this column of cells, were the column a vacuum; but the moisture freighted with the elements of the soil, is in the way, and will be carried ahead of it, if we can find a vacuum into which it can enter; we will, therefore, turn our attention to this matter; when the heat commences its action on the top cell of this column, sending off steam through its fine orifice, it leaves a vacuum in this cell, into which the fluids, from below, are brought; the elements of the soil, being less subject to the action of heat, would be left on the top of this cell in the form of scum on water, and when sufficiently thick to prevent the steam from passing, would commence to protrude through the orifice in the form of a bubble; this little bubble or cell continues to increase in size by steam continuing to enter it; meantime the chemical action, which formed the column, is at work on the outside of this cell, and by the influence of the steam within, and the action of the sun without its starch is changed to cellulose; starch and cellulose being composed of the same elements in the same proportion but differently arranged.

9. The limit to the size of this cell is fixed by the hardening of the cellulose; when this becomes so dense as not to easily admit of further distension, the pressure of the steam opens a small orifice on its top, and commences a new cell, this one fills with fluid and the evaporation continues. Some might question, whether, the external pressure might not destroy this delicate cell in a state of formation, but bear in mind that this cell is increased in size no faster than the pressure of steam increases, and that this pressure sends a

corresponding amount of material to be changed to cellulose; further, that this cell is held in close contact with the elements within by the pressure of the external air, which gives to it the spheroidal shape, the pressure being equal on all sides; consider, also, that this cell would be always closed by the starch, except when pressed open by the steam; it is probable that a small amount of albumen is present in the formation of the cells, and that it is afterwards removed to the seeds; this would give additional strength to the new forming cells. It is the opinion of some authors that this albumen is at last deposited in the seed, as none is found in cells: this, I judge to be correct, and that the reason why it is removed from the cell is because it cannot combine with the cellulose, it containing nitrogen, which the cellulose does not, and therefore the circulating fluids remove it.

10. In order to be certain that this cell, in formation, would not increase in size so as to burst like a bubble, let us remember the nature of starch and albumen, and their elasticity; and further, that the same amount of heat is acting to form the cellulose that manufactures the steam, consequently, when there is little heat, and cellulose is formed slowly, steam is also generated correspondingly slow. We have a hint on this subject in the yeast plant. I stated that the limit to the size of this cell was fixed by the hardening of the cellulose; by this, I meant that it is fixed for the time being, but cells, in general, continue to increase in size, simultaneously, for a time, both in Vegetable and Animal Life. It is not to be supposed that but one column of cells is forming at one time in the stem of any vegetable, but the principle that sends up a single column,

will send others at the same time, and the principle, on which one cell is divided will divide others.

11. These principles, that is, evaporation by heat, atmospheric pressure and the nature of a vacuum, underlie all Vegetable Cell Formation.

12. To see how the cell below this new one, divides into two while this new one is forming, remember that the moisture is being carried through this, leaving the elements of the soil deposited in its course, and forming a septum of cellulose, making two cells; but how is this septum formed? It is evident, that as the current passes through the center, it would leave the elements; they being heavier, would be crowded from the center by the rising current, therefore, a septum would be formed each side of the current, and when these became so thick as to leave no room for the rising fluid, they would be brought together by pressure of the fluids in the two halves, which pressure would, also, open an orifice on the top of these two new cells; the foregoing accounts for the readiness, with which wood may be split longitudinally, that is, the septum being formed double; the pressure in these new cells keeps a small orifice between them, through which fluids circulate. It is stated by one author that cells divide horizontally as well as longitudinally, and if they do, they must of course be formed by obstructed currents being turned and passing through side orifices, but in this case, the columns would become continuous, at certain points, with other columns and prevent the splitting of wood; therefore, I conclude that this formation, seldom, if ever, obtains; the pressure from above would give the cells, in some cases, that appearance. It will be understood that no chemical union of elements takes place between the two

halves of the septum, but they are simply pressed together, otherwise the wood could not be split.

13. The Pleurenchyma, Fig. 2, or oblong lapped cells, coming next in order, we may now consider; it is evident, by the length which many of them attain, as, wood fibre of our forests, that they are composed of materials so inflexible as not to be readily bent, and, consequently, form a cap so impregnable that evaporation cannot take place through it, and, therefore, it takes some point above the cap, which is more porous, to commence a new cell. These cells divide by forming a septum in the same way that the Parenchyma do, except that the current is passing down, instead of up.

14. Third, in order, we have the Trachenchyma, Fig. 3, which is nothing more nor less than the Parenchyma with its separating walls above and below carried away by the force of the circulating currents; the above is a correct description of the ducts of the stems, because there is no way of sending up a column of cells where nothing exists, but to form, first in Parenchyma; but the ducts of the roots form differently.

15. Fourth, and last, the Cienchyma, Fig. 4, shown in the rays which diverge from the center of wood, claims our attention; these, when regularly formed, and ending with the stomata, do not differ essentially from the Parenchyma, except, that their length in a horizontal direction is greater in proportion to their height than the Parenchyma are when they first form; in the formation of Cienchyma the evaporation takes place through the stomata; these cells always commence when the first columns of Parenchyma are sent up at the heart, and continue to form, in a horizontal direction, as fast

as the vegetable increases in diameter, thus keeping their ending at the stomata upon the surface; the accidentals are mere intercellular spaces filled with gum, or some peculiar combination produced by the kind of vegetable. The Agricultural report of 1875 contains an illustration of the fibres of cotton and linen after they had been acted upon by chemical agents, it appears that after the main columns are sent up in Parenchyma that the Cienchyma commence on the sides of these columns and form cells on each side in a horizontal direction leaving their outer ends, comparatively detached,so that after the applicati on of acids they entirely separate; this accounts for their flexible texture.

16. A query might arise with some, whether, the wood fibre of the exogenous growers, being formed from the top downwards by the cambium, is not an exception to the general laws of formation which have been set forth.

17. Let us see; if we cannot show the action of these laws here, it will of course, form an exception. The action of the Sun is the more powerful the nearer we approach the Earth, the rays being reflected from its surface; the evaporation can take place through the Cienchyma, passing out at the stomata, thus leaving a vacuum, and the pressure of the atmosphere, can act directly here, instead of indirectly, as in former cases; the cells, however, would take a different shape, from the Parenchyma becoming Pleurenchyma, that is, the lower end of the cell, would become so thick by the force of gravity that a point above would be sought where evaporation could take place to commence a new cell; therefore, this formation can be no exception

to general laws. Branches and leaves may, with all propriety, be considered as stems. The branches generally commence at the heart of the wood, that is, if they come from the main trunk, they come from its heart, and if they come from branches, they come from the heart of the branches; and leaves come from the heart of the bark, that is, they come from the new bark; consequently both branches and leaves, in general, put forth from new growth; but occasionally a branch arises through the Cienchyma of old trunks. Reasons exist for these phenomena, which are the following: all stems, whether principals or branches form the first column of cells, thrown up at the heart, from the crude sap and form in Parenchyma; and while these new parts are forming in Parenchyma, the Cienchyma also commence, and it is through some of these that the heart of the branches originate, and they form in the same way that the heart of the main trunk formed: it will be seen that the branches could not, easily, commence their formation under several layers of wood and bark for two reasons, one is, that the action of the sun would not be as powerful, which is peculiarly essential in sending up columns of cells, and the other is, there would, in general, be no crude sap to form Parenchyma. The leaves commence their formation in the new bark at the stomata under the scarf; they form from the crude sap, and form the veins of the leaves, in embryo, on the same principle as branches, but being composed of the same materials that would form bark, were it elaborated by the sun and carbon, and being confined in its embryo state within the bark or other leaves, so that evaporation can take place only at its edges, it must, necessarily form flat; was it composed of the same ma-

terials as branches, it is evident that as soon as it was exposed to the action of the sun it would commence sending up cells on the top side of the leaf; as, in prickly pear. We become aware how exceedingly fine these cells must be when we reflect that thin as a leaf is, it contains three layers of cells. In all exogens, and many endogens of our climate, the fluids that form branches and leaves, are obstructed in returning by the dense character of the bark; but in Tropical climates where there is no winter to harden the bark, we sometimes find neither branches nor leaves, the bark serving to elaborate the sap. It seems a peculiar providential arrangement that where elaboration of sap is requisite there are always fluids that are sufficiently volatile to be drawn into leaves, or bark that acts as leaves in evaporation and elaboration; this is seen even in the formation of the embryo in the seed. It may be query with some, that as the systems of cones that form the different layers of wood, in exogens, are Pleurenchyma, whether the extention at the top each year is not formed in the same way, but by examination, they will see that the crude sap, which ascends through the Pleurenchyma of the sap wood, on commencing the formation of the terminal bud, does it in Parenchyma, and continues this kind of cell on the next year so long as it is ascending, that is, the the cells at the heart must be in Parenchyma, because there is no possible way of sending up a column of cells where nothing exists, but to form in Parenchyma and on the principles already described; it is for this reason that the Parenchyma are found in all vegetable substances, and the only kind in some.

18. Secónd, in the subdivision of Cell Formation, come the cells of the root; it becomes evident that the

small rootlets, and all the absorbents, are formed from the top downward by the rising currents of fluid, which, in its way, leaves, first, the grosser materials for bark; and as it approaches the tube from all points, chemical action retains sufficient of the elements to form a thin film of starch, which is carried in and lodged obliquely on the inside of the column that is forming; and when this film is changed to cellulose and becomes too dense to allow the current to pass on its sides, a new film, will, of necessity, commence on the same principle as the former, thus commencing new rootlets or absorbents; but the main body of roots must necessarily be formed by the descending cambium, otherwise they would not be elaborated. The heart of all absorbents form first in Trachenchyma, these afterwards become main roots by the descent of the cambium and new absorbents form; so far as I have been able to examine, with nothing but an ordinary microscopic glass, the force of the current carries the film inward and lodges it against the inside of the tube so that they overlap each other; in pulling apart fine rootlets I observed that they parted obliquely, showing that they formed, by layers, in that direction; and, in others, I could not see this distinction and so far as I could learn they appeared to have formed by the accession of simple particles, because when parted they appeared fractured. Some authors have given drawings, of what they call rootlets, which resemble the Parenchyma closely pressed together, but it appears to me that this must be after they have taken on layers formed by the descending cambium. If the first line sent down to form a rootlet, does not form in ducts I am unable to comprehend how they do form; that some form in this manner, I know, the center ap-

pears but little larger than sufficient to receive a hair and is smooth and glossy.

19. Third, in order, of Cell Formation, we have the Cytoblast; these small granules of starch and albumen slightly coated with cellulose, are formed from the superabundance of the elements of starch left after the evaporation of water; they are formed by cohesive force; granules too large to be admitted through the orifices of the cells, remain in them, and being carried about by the rising currents, change their outer coats to cellulose; remembering that starch and cellulose are composed of the same elements in the same proportion, but differently arranged, it is easy to comprehend how this takes place by the action of heat on their outer coats. In all works that I have examined where cells are drawn into all manner of shapes by pressure and tension, I have always noticed in drawings of these different shaped cells, that where there was an eddy, out the way of the current through the cell, that it always contained the Cytoblast. I know of nothing to prevent these Cytoblast from becoming permanent cells, were the cells that contain them destroyed and they remain where the fluid and Sun could act upon them.

20. Fourth, in the subdivision of cell formation, we have spores; these being the reproductive organs of the Cryptogamia, consisting of simple cells, are formed by laws already known, that is, at any point where a pore exists and a sufficient amount of starch to raise a film, the cell can commence, these cells often divide into several, the same as other seeds, and in the same way that other cells divide.

21. The instance of a spore first producing a Thallus,

and this Thallus producing a spore, which, in its turn, produces a fern, holds in my mind, a key to the origin of all vegetable seeds.

22. Fifth, in the subdivision of Cell Formation, comes the blossom; the facts, that leaves change to sepals of the calyx, sepals of the calyx to petals of the corrolla, petals of the corrolla to stamens, and stamens to pistils, are phenomena too well understood to need comments; but the cause of inflorescence exhibiting these phenomena, I have judged, as properly forming one of the heads of Cell Formation; that is, the same causes exist for the phenomena above described that exists for blossoms; namely, juices becoming rich, in the first instance, by cultivation, and in the second, by elaboration.

23. It is a principle, well understood, that no vegetable could be formed without the materials, of which it is composed. When a vegetable has thrown into green leaves all the fluid it possesses, which is sufficiently volatile to enter them, those which are left are, of course, too rich, and thick to give the leaf bud, and this cambium which has been elaborated deposits, as it passes along, in the axial or terminal bud place, a flower bud instead of a leaf bud, the juices being too rich and not sufficiently volatile to give the leaf bud; but yet, in most cases, we find enough of the elements of chlorophylle remaining to make out a calyx; then the next most volatile elements are drawn into petals of the corrolla, and of those that remain, such as are suitable are drawn into filaments and anthers and the pollen is carried up by the same law, that is, evaporation, and is dried by the heat and air, forming a fine powder; meantime this blossom has been forming the

ovary of the pistil, sending up the style and throwing out the stigma; the residue of its materials, which must be seen to be of the richest character, it deposits in the cells of the ovary, because it can carry them no farther, receiving back, at the same time, the pollen from the anthers, which left it destitute of some element or combination of elements required to perfect the seed. These phenomena have taken place nearly simultaneously, and for the reasons just given; the colors of the corrola are, of course, due to a difference in their refrangibility the same as any other colors. It will be found, on investigation, that the leaf buds which finally end in branches, always start from the heart of the wood, while the flower bud s formed of the descending cambium which is obstructed by the leaf bud below, and being held to one point, is drawn into a flower bud; and the mixed bud has its origin at the heart and also takes in the cambium; the same principles hold in the flower bud as in the leaf bud, that is, they are developed in a folded condition with evaporation at the edges only.

24. It is evident, that all these operations have taken place by the addition of cells, because there is no other structure in vegetation, therefore, the seed also must be formed of cells.

25. Sixth, and last, in the sub-division of Cell Formation, we have the seed. We left the materials of the seed deposited in the ovary without saying how they were deposited, or on what principle. We will suppose the first cell of a seed to be formed on principles already described; it contains the elements in exact proportions and combinations to build its own species; it can get no other, because this vegetable can

manufacture no other, therefore, it must build an embryo corresponding with the one, which furnished the materials, with this exception, that as the materials are rich and condensed so the corresponding embryo plant, will be small but rich; nevertheless it must form by the additions of cells, consequently, when it is acted upon by moisture and heat to swell the parts it is ready again for action and growth; we perceive that the materials, of which the seed is composed has been twice elaborated, once by green leaves, and once by petals of the corrolla.

26. It will be remembered that while the embryo plant is forming, the coverings of the seed remain soft and sufficiently porous to allow evaporation to take place through its coats.

27. The foregoing gives a key to the perpetuation of the same species from the same seed, because the seeds of different vegetables, are composed of different elements or the same elements differently arranged.

28. I observed before, that spores of the cryptogamia give a key to the origin of seeds, for I cannot, possibly, make myself believe that seeds were firs' formed, in the perfection, in which we now find them, because there existed no conveniences for fixing them up in this way.

29. Although I am as perfectly sanguine in the belief, that an infinitely intelligent Spirit is the author of this harmonious Universe, as I am in the theory which I am now setting forth, yet I have always found that God has a way of doing all that He does.

30. In treating these Cell Formations, I have aimed to touch every point, where I supposed, a query might arise in the mind of one versed in structural botany;

but I have not deemed it necessary to say anything on the different shapes of cells produced by pressure, tension or addition. A question might arise, as to why, if the main body of a vegetable were severed above the root and set in water, will it not grow? The reason is there are no materials to form cells, except in the air plants; the water dilutes the sap in the cells and unfits it for use; if the vegetation is placed under favorable circumstances, evaporation will take place for a time and the water be drawn up, but the cells at the top soon dry up and disorganize because there is no starch to keep them closed when evaporation is not taking place, the vacuum is destroyed, and the water descends.

CHAPTER V.

The Power that Carries up the Fluids.

1. We come now, to the second part of the manner of Vegetable Cell Formation, and that is the power, which carries the fluids to such extraordinary heights as they sometimes go.

2 There is nothing that is so great a cross to my natural feelings as to be obliged to call in question principles, set forth by individuals, whose indefatigable labors have given to the world such infinite treasures, as we find in most of our authors on natural science, and, on whom, I am so dependent for my own attainments, and present capacity for enjoyment; and I am more happy than I could easily express, to know that the views, which I am about to call in question, are not considered nor treated by authors as well established; at least, they are not so considered by those, with whom I am acquainted.

3. Therefore, knowing how difficult it is for a person to receive a new theory, when the mind is preoccupied by another on the same subject, I will make a few observations on the principles termed endosmose and exosmose, or osmose; and I will simply say that from all, which I have been able to learn from books, and the experiments therein set forth, together with all that I can deduce from laws, with which I am acquainted, I have been able to see nothing in the principles termed endosmose and exosmose, but what can be shown to depend upon atmospheric pressure; capillary force; or chemical action.

4. I will proceed to set forth the law, which governs what is styled capillary attraction, and to demonstrate the amount, on which we may, in any given case, depend.

5. To set forth the law governing this principle, I observe, that it is a well established fact, that fluids press with equal force upon all surfaces, at the same depth, with which they come in contact; and that the area of similar figures are to each other as the squares of their like dimensions; consequently, the area of different circles are *not* to each other as their circumferences.

6. To understand the law concerning this principle, we have, simply, to remember that the inner surface of tubes of the same height, are proportional to the circumference of the base or end of the tube; and that the solid contents are to each other as the area of their bases.

7. We will solve a few problems on this principle: if we take a circle which is one inch in diameter, its circumference, will, evidently,—1 inch x 3.1416—3.1416

and its area will—1 inch x 1 inch—1 inch x .7854—.7854; if we take a circle 2 inches in diameter its circumference will be 2 inches x 3.1416, that is double the first, and the pressure on the inner surface of the tube would be double the first, and its area will be 2 in. x 2 in.—4 x .7854—to four times the area of the first, consequently there would be four times the solid contents, and four times the water to be raised, therefore, the pressure could send it to only one half the height; now, it becomes obvious that any increase of the diameter of the circle would increase the amount of weight to be raised in a greater proportion than it would increase the power to send it, and, consequently decrease the height, to which it could be sent.

8. Again we will take a circle, which is one-fourth of an inch in diameter; this would give a circumference one-fourth of 3.1416—.7854, but it would give an area —to one-sixteenth of .7854—.0490; in this case we have one-fourth the pressure that we had when the diameter was one inch, but we have only one-sixteenth the weight to be raised, and could, therefore, send it to four times the height.

9. We will, now, suppose the diameter of the circle to be one-sixteenth of an inch; in this case the circumference would be one-sixteenth of 3.1416, and the area of the circle would be one two-hundredth and fifty-six of .7854, giving one-sixteenth the pressure of the inch circle or tube, but only one two-hundredth and fifty-six of the weight to be raised; therefore, it could be sent to sixteen times the height that it could be sent in a tube, one inch in diameter; this is all on the supposition that the vacuums are perfectly formed as in nature.

10. It is known, that a tube, one inch in diameter, containing a vacuum, will support a column of water over thirty feet in height, therefore, a tube, which is one-fourth of an inch in diameter will support a column of water four times thirty feet or one hundred and twenty; and a tube, which is one-sixteenth of an inch in diameter, would send and support a column of water, which is sixteen times thirty feet or four hundred and eighty feet in height.

11. The foregoing demonstration contains a principle that cannot fail to satisfy any mind; it is obvious that when the diameter of the tube is greater than a unit, the weight of the water to be raised will increase in a greater proportion than the power to raise it; but when the diameter of the tube is less than a unit, the weight of water to be raised will decrease in a greater proportion than the power to send it, and, therefore, can be sent higher; this same principle is shown when open tubes are used, and also in plates of glass, that is, the weight decreases more than the surface pressure; in plates of glass the surface pressure remains unchanged, while the weight is constantly decreasing.

12. The rise of fluids between plates of glass is accelerated because they are open on one side of the plates, was the open side closed the rise would be gradual.

13. Up to the very hour, when I commenced this chapter, I supposed the Siphon to be the principle in carrying the fluids above where they could be sustained by the atmosphere, which I supposed to be about thirty feet, and that all the credit, which was due to capillary attraction, was owing to the difference of pressure on the different ends of the tube when the ex-

periment is tried with open vessels; that is, as the square of the distance from the center of the earth increased so the pressure would decrease; I had not, at this time, taken into consideration the idea that the atmosphere could send the water no higher than it had power to do, although the Siphon might form a vacuum above.

14. I had, really, solved one problem on the subject with the principle that gravity decreases as the square of the distance increases, when the thought occurred to me that the height, to which water is raised, in capillary tubes, is in proportion to their diameter; I immediately set myself to investigating the properties of different sized tubes; and knowing that the area of different surfaces are in proportion to the squares of their like dimensions; and, also, that fluids press with equal force on all surfaces, with which they come in contact; I saw the principles of capillary force before I had solved a problem on the subject; therefore, I concluded to deduct very much credit from the siphon and give it to what is called capillary attraction, which after all, is nothing more than atmospheric pressure acting through the tubes. This view of capillary force, that is, the difference of pressure on different ends of the tubes, was first presented to my mind by my brother, Zimri W. Burnham, about twenty years ago. I was at the time engaged in mathematical studies, and simply listened to his explanation on the subject, and this I supposed to be correct, and I am now satisfied beyond a doubt that it is correct, that is, this reason is the cause why fluids ascend at all in tubes; but this would render no reason for their rising higher in smaller tubes. To say that this reason just

given is not correct, would be equivalent to saying that gravity does not decrease as the square of the distance from the centre increases.

15. It may be a question with some, how the force acts on the inner surface of the tube to send the fluid up, but a little investigation will satisfy the mind on this point; to comprehend this, let it be remembered that action and reaction are equal, and, therefore, all of the force exerted on the inside of the tube is reflected towards the centre, so that the fluid at the centre of the column is under greater force than that which is in contact with its inner surface, and this pressure holds it up on the same principle that any substance tightly crowded into a tube, would be held, were it unsupported at the bottom; this pressure at the centre, together with that of the air below, and the vacuum above, are the reasons for the fluid's acting in proportion to its quantity and the surface of the tube. From the foregoing illustration, it will be seen that when the diameter of the tube is so great that the reacting forces from the surface are not sufficient to meet at the center, then the column will be unsupported, and the fluid will not rise at all.

16. I supposed that all of the force of motion, both in the animal and vegetable were due to ordinary atmospheric pressure in connection with vacuums, before I understood capillary attraction, which might, with all propriety be called, capillary force. But I am now well satisfied that atmospheric pressure, unaided by the principle of capillary force, would be insufficient to carry the blood to the extremities of the arteries, or to bring it back to the heart, were it not for the vacuum there sustained by the powerful capillary

force at the lungs; I regard the want of an understanding in this principle as the true cause of incapacity to handle many phenomena of both Animal and Vegetable life. It may be supposed, by some, that the rise of mercury to about the same height, in different sized tubes, forms an objection to the theory of capillary force, which is here set forth; but we may remember that the cohesive force of this element is so great that it has no capillarity when open tubes are used, and, of course, the difficulties of its ascent would increase with the decrease in the size of the tube, when closed tubes with a vacuum, are used. There would, also, exist a difficulty in producing a vacuum in the tops of long tubes of water by working the piston for so great a length of time to obtain a small amount of vacuum, because the friction would increase in proportion to the vacuum obtained as the size of the tube decreased; but so long as the principle holds good, when open tubes are used, it could not, possibly fail to act in closed ones with the perfect vacuums formed by nature. Considering these principles established; that is evaporation by heat forming vacuums; and atmospheric pressure filling them with air, moisture, and elements of the soil; we will take them for data, and venture to turn our faces towards the Animal Kingdom. Here, again, as in the Vegetable Kingdom, we could not even enter, but for the great workers, which have gone ahead on the same track; the dissecting knives of the faculties of medicine have opened the way,—they have suspended their lamps and invited us to follow—and we enter in the fullest confidence that, at every step, we are placing our feet on terra firma, because we are not groping our way in the dark.

PART II.

CELL FORMATION OF ANIMAL LIFE.

CHAPTER I.

AGENTS OF ANIMAL CELL FORMATION.

1. In treating of the Cell Formation of Animal Life, I shall confine my exposition of the subject, entirely, to human beings; because the same laws hold good in the Cell Formation of the lower animals, modified by the particular character of each; and, also, because my main object, in these essays, *is* the Cell Formation of the human family.

2. As, in the Vegetable Kingdom, we first took a view, which is clear to everyone, of the results of the presence or absence of heat, moisture, air, and elements of the soil; so in the Animal Kingdom, we will first enquire into the obvious results of the presence or absence of heat, moisture, air, and food of Animal Life; the last standing in the place of the elements of the soil in Vegetable Life.

3. It is a fact, understood by the most ordinary intellect, that a certain amount of heat on the surface of the body, as well as that generated within, is requisite to keep a person from freezing.

4. Although, life is maintained in very high latitudes, where the temperature is very low, without any artificial means of heat; yet, it will be remembered that an amount of clothing is required, proportionate to this condition, which will retain the heat generated

by the body, thus causing it to act as external heat; animals, also, are protected in this respect, by their natural clothing.

5. Although, a want of moisture would not produce death as soon as a want of heat, yet, it would be equally sure; we should be in a more unfavorable condition for life and development than a vegetable, were we deprived of a circulating fluid, in which to convey our nutrition, and carry off disorganized matter, because we are, by action, destroying our systems so much more rapidly than they are destroyed.

6. We find, also, that we cannot live as long without air as we can without artificial heat; and, certainly we cannot build or repair this house without food, the building materials.

CHAPTER II.

General Principles of Electricity.

1. Before entering upon the illustration of the Cell Formation of Animal Life, I will present one more principle that will be required in the exposition of the subject, and that is the nature of Electricity. In setting forth the nature of this element, I shall not enter upon a discussion on the different views of philosophers on this subject, for two reasons, one is that I see no essential difference *in* their views; one party maintaining that, what is called electricity, is an exceedingly fine element, which pervades all space, and fills all cavities of bodies, and that all special phenomena of this element is due to its motion; and the other party calling this element caloric, and ascribing to its special phenomena, a collection of this material,

thrown into different forms of motion by different causes; and the other is, because the result would be the same which ever view is taken; I shall, therefore, confine myself to the known and well established phenomena exhibited by this element.

2. It is a fact, well understood by philosophers that the element, the motion of which produces the effect called heat, exists in all cases; at all times; in all places, and under all circumstances, in a greater or less degree in an unobserved state

3. The circumstances, under which this element becomes sensible, or produces the effects, which we call heat, are placed, by philosophers, under four heads; namely, first, when this element, radiated from one body, meets and is reflected back by another; as, the rays of the sun, received and reflected by the earth; or when the rays from a burning body are partly reflected and partly received by a finger, that gets burned; these phenomena, although, constantly witnessed in every day life, may not be well understood, that is, the true cause of the burning process may not be comprehended. Second, an electrical current, produced by any cause. Third, in chemical action. Fourth, in friction.

4. Now, I think the heat, produced in these different ways, may be shown to depend, in every case, upon the same principle and condition, although not produced by the same cause; and further that this principle and condition, consists in a removal or change of parts of matter disturbing the arrangement of this mighty element, and causing it to rush from all points where it is unobserved to the place of disturbance, in order, to establish itself upon the new conditions. To

know that this element does take form according to the body, which it surrounds and fills, remember its action in spheres, magnets, and wires.

5. First, when the rays from the sun or any other body, are met and partially stopped, entering between the particles, they rapidly send off moisture, removing parts, and leaving vacuums, into which this powerful element instantly rushes, producing the effects, which we call heat; and this sending off of moisture, and rushing in of electricity, constitutes the burning process in this case.

6. Second, an electrical current from a battery, depends upon the amount of removal of parts for its force; and a current from the machine, depends upon compression, and friction, which are removals, together with confining this element and sending it in one direction, for its tension.

7. Third, it is almost unnecessary to say that chemical action, consists in a removal of parts.

8. Fourth, and last, what is friction but a removal of parts?

CHAPTER III.

Theory of Animal Circulation.

1. In the Vegetable Kingdom, we first took a view of Cell Formation, and then enquired into the causes, which had power to send the fluids where they were needed; but in the Animal Kingdom, we will reverse this order, and learn, first, the causes, which keep up the circulation of the blood, which stands in the place of fluids in the Vegetable. A cause must be sought, that can act on the circulatory system,—the motive power must always be adapted to the machine.

2. In treating this subject, I shall first set forth my own theory and reasoning on the power employed; and, then, introduce other theories, and give my views upon them, showing their incapacity to account for the phenomena of the system.

3. If the reasoning, in the foregoing chapter, on heat, is conclusive, we have only to ascertain where, in the human system, this action and removal of parts take place, in order to know where the heat is produced.

4. First, the circulation of blood produces a constant change by friction and removal of parts, drawing after it a current of this subtle element; hence the blood is always warm.

5. Second, the capillaries are subject to friction, both by motion of the blood through them, and, also, by muscular action, and, indeed, these organs being in every part of the system, and being the seat of the main chemical changes, that take place in repairing the body, become the great heat generators, as they are called, of the body, and render a satisfactory reason for its warmth; here, then, is a place where a large amount of heat is constantly thrown and generated; this heat, ever accumulating in the capillaries and radiating towards the surface, gives to the capillaries of the skin, and muscles under it, not only the warmth generated in them, but that radiated from the rest of the system; this heat, seeking equilibrium, passes through the adipose tissues into the folicles of the prespiration tubes, and hydrocarbons from the tissues follow up the vacuums, formed by the heat, into the perspiration tubes, and meeting the air, combustion takes place in the tubes and discharges carbonic acid

and vapor; and this combustion with the removal of the hydrocarbons, which accompany it, leave the vacuums, which give to atmospheric pressure, assisted by nervous influence, power to bring the blood through the arteries of the systemic circulation; the source of the heat that constantly follows up the current of blood will be hereafter shown.

6. In analogy with what we found to be the condition of the capillaries of the skin, we find those of the pulmonic circulation in the lungs to possess, not only, the heat, generated in them, but that radiated from those of the systemic circulation of these organs. And this heat in seeking equilibrium passes into the folicles or air cells, and centering in the small tubes, that lead to the lobules or clusters, causes a large amount of this element to accumulate at these points; in other words this little tube becomes the focus of the cluster, and this heat, being followed up by hydrocarbons from the capillaries, that is from the blood as it is passing through them, on reaching the tops of the small tubes meets the air, producing combustion; and the vacuums formed by it are the real causes which give to atmospheric pressure, assisted by nervous influence, power to bring the blood to the lungs by causing the heart to contract, and stands as a balance power to all the rest of the system bringing the blood back from all other circulations. As the combustion is constantly taking place, it keeps a current of air passing to these points, as well as in the perspiration tubes, on the same principle that a current of air always sets in towards our fires, and on the same principle that all air is kept in motion, that is rarefaction or vacuum; although the air enters the lungs period

ically, yet that, which is always in them, acting by combustion, to form vacuums, is the cause of the current towards the tops of the tubes, that lead to the clusters, and the chemical affinity between the oxygen of the air, and the hydrocarbons, removes or retains such a part of the oxygen of the air as is necessary to do the work; and here, it appears to me that did there exist a store of adipose as in the tissue around the folicles below the perspiration tubes, there would be danger, from the large supply of air, that the combustion would become too rapid, hence, we see that the heat is regulated by the structure of the lungs being such as not to secrete a large amount of adipose. As the air in the lungs moves towards the combustion, the external air fills its place until the lungs are so distended that the pressure of the parenchyma, cartilages, and muscles, which have been prepared by the pressure of the air on the pneumogastrics to act in concert, is greater than that of the air contained in the lungs, and that of the air in the lungs is greater than the external air, and this condition allows the lungs to compress throwing out the air, gas, and vapor. It may be matter of query with some, that as carbonic acid is heavier than air, by what power it is moved out of the way of combustion; it must be moved by the layers of steam or vapor under it, formed by combustion of the hydrogen, the same power that takes it out of the way of the air in any other combustion, that is the vapor, on which the carbonic acid rides is lighter than air.

7. Now, can it possibly be supposed that the lungs and their appendages, constitute an apparatus, which, once set in motion, will continue to act without a motive power? If this power does not consist

in combustion sustained in the tubes, in what *does* it consist? It cannot consist, mainly, in the reflex action produced by the pneumogastrics, because severing those nerves, does not destroy respiration until the want of air, in consequence of the collapsing of the vocal cords produces inaction in the tubes. The reasons, I conclude, why the severing of the medulla-oblongata, produces instant death, are owing to the collapsing of the tubes, both in the skin and in the lungs, and, also, to inaction in the great sympathetic, produced by section of the medulla. Another question might arise, that is, why does not the combustion follow up the heat into the tubes, that lead to the clusters? With the same propriety, might we ask why the fire does not follow down the wick of a lamp? These passages are filled with the currents of hydrocarbons, hence, they must reach the air, the points of active combustion, before they are consumed. An objection has been raised to the theory, that combustion is sustained in the air-tubes of the lungs, on the ground, that it would make the blood, in the lungs, warmer than that in the rest of the body, which is found not to be the case. It will be remembered, that the very small tubes which enter the clusters of cells, are all situated at some little distance from each other, and that the amount of combustion sustained at any one is very small, and is surrounded by fresh air, further, that the blood, in the lungs, is constantly changing, that is, the warm blood is flowing away, and a supply of the fresh entering; would a hundred lamps or candles, placed ten feet from each other, so as to cover a square or circle, create a perceptible heat? It appears to me, that this heat would be hardly sufficient to warm the lungs as much as the

air would cool them. It might, also, be supposed that the combustion would be in danger of injuring the parts, but as the mucus membrane is composed largely of nitrogen, and protected by the mucus fluid, and that the combustion is not in direct contact with the membrane, but only at the tops of the tubes, I think no danger of that kind could exist; and in the perspiration tubes, also, a current of fresh air is constantly passing. Now it becomes evident that the current of hydrocarbons, which is passing from the tissues of adipose that lie under the follicles of the perspiration tubes, enables this tissue, by the vacuums which it leaves, to secrete its oleaginous substance from the capillaries of the muscles; and that the current of hydrocarbons which is passing through the tubes in the lungs, enables the air cells or follicles to secrete the hydrocarbons from the capillaries of the pulmonary artery, which contains venous blood; these hydrocarbons, being lighter than the rest of the blood, are easily drawn into vesicles.

8. It seems to be matter of doubt with some, where the combustion takes place, or whether it takes place at all; that carbonic acid is formed somewhere, and emitted at the perspiration tubes, and the tubes leading from the lungs, being a known fact, it remains for us to conclude where it can be done. It is known, that the albuminous group, contained in the food, which we receive, as it continues to be manufactured into different tissues and organs, becomes more and more elementary in character, until in the adipose it is nearly pure hydrocarbons.

9. Can the union of oxygen with hydrogen and carbon, take place in a current of blood? There is no di-

rect supply of fresh air there, without which, very active combustion of these elements cannot be sustained, where, only, can we find a supply of fresh air? Is it not in the air tubes of the lungs, and in the perpiration tubes of the skin? Here, then, in these places, it becomes possible for very active combustion to take place, and in no other, upon any principles with which we are acquainted; hence, I think, we shall not be presumptuous in considering these arguments as conclusive, because from the amount of carbonic acid emitted it is evident that the combustion must be rapid; but when the capillaries become sufficiently obstructed to clog circulation, the oxygen, which has been disengaged by destruction of nutritive elements, does sustain an amount of combustion, sufficient to raise what we call fever, but this condition is not favorable to building up the system, but, on the contrary tears it down.

10. It will not do to conclude that the blood, once set in motion, will continue to move, because the pressure of the atmosphere would soon bring it to rest, were not the causes that set it in motion perpetuated. Now, shall we say that nervous influence constitutes the whole motive power of the human system, without any assistance from atmospheric pressure, for ordinary atmospheric pressure cannot act without the influence of vacuum: it is, certain, nearly enough to make us believe that the nervous system is the spirit, itself, if it can perform all this work of its own accord unassisted by any other force, but as the nervous system remains after death, I think, it will not do to assign all of this power to its influence.

11. We have the pressure of the atmosphere acting

on all parts of the body, and if we can find the vacuums, we can bring this pressure to assist nervous influence in sending the blood to these points; where are those vacuums to be found? It must be where the combustion has taken place, that is in the air tubes of the lungs, and those of the skin: it must be seen, that vacuums and ordinary atmospheric pressure, would be sufficient to cause a current of blood to move, yet it would not act with the facility required, without the influence of the reflex action of the nerves to increase this pressure, as we shall be well satisfied, hereafter.

12. The air or perspiration tubes of the skin, then, taken together, form an amount of vacuum, that gives to atmospheric pressure, increased by nervous influence, power to cause the left ventricle of the heart to contract with force sufficient to send the blood to the extremities of the arteries of the systemic circulation, which are capillaries.

13. When the blood is thrown from the left ventricle of the heart, it leaves a vacuum, into which the blood from the left auricle, by the contraction of the heart, is thrown, leaving a vacuum in the left auricle, to which the blood from the lungs is drawn, leaving a vacuum in these capillaries; and, here, again, besides the vacuum formed by the leaving of the blood, we find a great power, created by the combustion sustained in the air tubes that lead to the clusters of cells; the vacuum, produced by the leaving of the blood together with that formed by the combustion, gives to atmospheric pressure, increased by nervous influence, power to cause the right ventricle of the heart to contract with force sufficient to send the blood to the capillaries of the lungs.

14. Then the vacuums, left in the right ventricle, and the contraction of the heart, throws the blood from the right auricle of the heart, leaving a vacuum, that gives to atmospheric pressure, increased by nervous action on the veins, power to send the blood from the capillaries of the skin where we started, and, also, from the capillaries of all of the systemic circulation. It will not be supposed, of course, that any part of the circulatory system is at any time empty, nor that but one side of the heart contracts at once, because it is a fact, with which most school children are acquainted, that the hearts contract together, commencing on the auricles, and ending with the contraction of the ventricles, so that, at the same instant, that the blood is sent to the lungs, it is, also, sent to the capillaries of the systemic circulation; thus, we see that the vacuums left in the ventricles by the former contraction, allows the auricles to contract, and the vacuums, always sustained in the capillaries of the lungs, and those of the skin, allows the ventricles to do the same.

15. It will be seen, that the right side of the heart, in making its demands on the veins, includes the vein leading from the liver, and, also, the thoracic duct with lymphatics generally; and that the vacuum in the thoracic duct, makes a demand through the lacteals, on the second stomach, leaving a vacuum, which makes, at once, a demand, on the liver for its bile; on the pancreas for its juice; and on the stomach for its food; this accounts for bile and pancreatic juices always being present just when they are needed; and it, also, shows the motive power, which enables the liver to secrete its bile, as well as the pancreas its juice; it,

also, gives, in connection with the pressure of the air, and nervous influence, power to cause the stomach to act in in the digestion of food, and this power, being continuous, produces, when the stomach is empty, the effect which we call hunger, that is the vacuums are drawing on the stomach, also, the continuation of this power, enables the glands of the mouth to secrete the saliva, and draw into it an extra quantity when it is needed for moistening the food; of this fact, we may be convinced, by opening the mouth a little, and letting the air dry off the moisture, and observing that little or no saliva flows while the mouth is open, being prevented by the pressure of the atmosphere, and, then, closing the mouth, and noticing how quick the saliva is admitted; further, as the food in the mouth shuts off the air an increased amount of saliva enters at that time. Mastication on either side of the mouth, causes the food to shut off the air, and produces an additional flow of saliva while it lasts; and, on changing the food to the opposite side of the mouth, we find the same phenomena there, also; the mouth waters, as it is called, because it is brought together at sight of food. Idiots whose tongues are so large as to shut the air from the glands, dreul continually with the mouth open.

16. The demand, which the systemic or hepatic vein together with the second stomach, makes upon the liver, gives to it power to call the blood from the systemic artery leading to it, and, also, from the portal vein, which makes its demands on the systemic veins of the stomach, second stomach, pancreas, and spleen; it will not be supposed that we doubt the concert action of the nervous system, as described by au-

thors, in general, in relation to any part of the action taking place in the system.

17. A question might arise, as to why it is necessary to have vacuums, formed by combustion, in the tubes of the lungs, and in those of the skin, and in no other place; there are two reasons: one is to supply air for the combustion, and the other is, because a greater power is required to send the blood from larger organs to smaller, than to send it from smaller to larger ones, not only must the force be greater, but it must lie in each particular cell and tube. What fearful destruction would follow, were the heart to contract voluntarily, involuntarily, or by pressure, without vacuums ahead of it; too see how easy the heart could contract by pressure, take the left hand in the right, and move it backward and forward, and we can see that this motion does not tire the muscles of the left arm; the heart *does* not contract by volition, therefore, it *must* contract involuntarily or by pressure; did it contract without assistance from pressure, it must soon become diseased, and we should be made sensible of its motion; if the muscular power of the heart, has the main influence in circulation how can we account for this action in animals which have no heart? These creatures show the power of vacuums and atmospheric pressure as clearly as vegetable life; that the heart does contract by pressure, we hope to be able to show so clearly that no doubt *can* be entertained on the subject, and further, that nervous action goes to increase this pressure, and is the motive power of action in the circulation of animals, which have no heart.

18. It might be questioned by some, whether, the vacuums in the air tubes of the skin, and in those of

the lungs together with the pressure of the air increased by nervous influence, would have sufficient force to carry the blood to the extremities of the arteries; but recollect the pressure of the air in carrying the blood through the arteries, acts on the principle of capillary force; the arteries being round, and not, under the circumstances, compressible by pressure on the outside, because the contractions of the heart throws the pressure on the inside of the base of these organs, which are cones, the same as it is thrown in vegetation; but not so in carrying the blood through the veins back to the heart; here the pressure acts on the outside of the cones, and the organs, continually increasing in size tends to diminish capillary force, whereas, in the arteries they continually decrease in size, and increase in capillary power; we find, also, that both arteries and veins are constructed with this view, that is, the arteries are not compressible by equal pressure on the outside and the veins are, therefore, the pressure acts externally on the latter, deriving little advantage from the principle of capillary force, but, mainly, from external pressure in connection with the vacuum in the right heart, and we will not forget that the great vacuum in the right heart is dependent on the powerful capillary force sustained by combustion in the air tubes of the lungs; a moment's reflection will convince anyone of the great advantages of an equal pressure on the outside of a cone with a large vacuum at its base, and we have seen the immense power of pressnre on the inside, when vacuums are ahead of it, in the Vegetable Kingdom; that combustion, sustained in such small detached quantities, can possess such immense power, is shown by the very small vacuums, in the cells of vegetables,

having power to lift columns of fluid to such extraordinary heights when influenced by the principle of capillary force; and this principle cannot fail to be comprehended when we consider the power of the hydrostatic press, and the force shown in this work under the head of Capillary Attraction or Force.

19. It might, perhaps, be supposed that the position of the vacuums, that is at the surface and in the lungs, would produce a tendency to circulation in one direction as well as in another, and that the influence would be to hold the blood at the vacuums; one might say that the arrangements of the heart, arteries and veins are such as to send the blood to the capillaries, and, also, to take it back in the direction, in which it goes, but what influence established this arrangement? We have seen that vacuums and atmospheric pressure brings the blood to the capillaries, and that, although, there are two influences to send the blood to the capillaries of the lungs and skin, yet there is but one to hold it there, and that is the vacuums, and opposed to this are the great vacuums in the auricles of the heart, and the pressure on the outside of the cones called veins; therefore, it is easy to perceive the power that carries the blood from the capillaries.

20. I have heard the query raised, whether the leaving of the blood, creates a vacuum in the heart under any circumstances; with the influence of vacuums ahead, it certainly does; but let us see what would be the result did these vacuums not exist; supposing the circulatory system to be full of blood and the heart to contract, the directions, in which the blood is sent, that is the pulmonary artery and the aorta would sustain a much greater pressure after the contraction

than the veins, and the moment the heart relaxed the blood would regurgitate from the points of greatest pressure; but some may suppose that it would be prevented from returning by the valves; how long, can anyone suppose, the valves would remain in the way against this pressure? What influence produced the valves if it was not the direction of the current? And what influence preserves them? Surely it cannot be an unusual pressure against them, although, they act, under certain conditions of the body in relation to position, to prevent the return of blood. And, now, we will investigate the result with the supposition that vacuums do exist ahead of the heart; we do not suppose that the heart is, at any time, empty, except at the moment of contraction, only that its elastic power, in springing back after the contraction, allows the blood to pass into it; but, perhaps, some may suppose that the pressure would be so great in consequence of the influence of vacuums that the heart could not relax but would be held by this force; there are two causes acting, which allow the heart to relax; one is, that as soon as the blood has left the heart, its pressure no longer tends to produce the reflex action of the great spmpathetic, and the other is, that as the blood is thrown out by a sudden impulse its tendency, for a moment, to regurgitate, in consequence of the pressure, destroys, for an instant, the influence of the vacuums, and this condition together with the one first named allows the heart to relax, and this relaxation forms the vacuums that allow the blood to pass in; thus, we see that no vacuums could exist at the heart were there none ahead of it, but with these, we are sure of the vacuums at the heart.

21. Perhaps some may question how the pressure

acts on the lymphatics, and on the thoracic duct; it acts on the lymphatics the same as on the veins, that is on the outside of the cones, but the *principles* differ in the thoracic duct; the mouth and the œsophagus taken together, forms a cone of gentle slant, with apex at the cardiac orifice, and has the pressure on the inner surface; and this pressure is renewed in the stomach by atmospheric force increased by nervous influence on its outside, this additional power together with the food in the stomach, throws the pressure on the inner surface of the second stomach, which is, also, a gently slanting cone, in order that the food may pass slowly through it; the liver, and also the pancreas, are acted upon by pressure, both on the outside and on the inside, the same as the stomach, that is the influence exerted by the heart and vacuums act on their inner surfaces, and atmospheric pressure increased by the action of the great sympathetic acts on their outer surfaces, and this same influence continues on the lacteals; the thoracic duct we find to be of equal diameter, and it is acted upon by the same force on its inner surface as organs already mentioned, and by its ganglia, which is pressure on the outside; thus we see that these vital organs have pressure on their insides on the same principle as the arteries, but, on their outsides the pressure acts on the principle in which it does on the veins.

22. It may be asked, why the action of the stomach, and the draft on the bile and pancreas, do not continue when the food has left the stomach; the food in the second stomach and the chyle in the lacteals, cuts off the power of the vacuum in the right heart, and when these are removed, the vacuum resumes its in-

fluence, and we are made sensible of its power by the draft on the stomach, which we call hunger; this is one of the positive evidences of the influence of the vacuums, and proves that they do exist. The shape of the stomach is such as to cause pressure to act on the outside in very different directions, and when the pressure on the inside is cut off by food in close contact on the inner surface, the same as food in the mouth cuts off the air, then the food is continually thrown around from its points of contact on the inside by the pressure on the outside, and wherever the food touches the stomach and cuts off the pressure on the inside, there the gastric juice flows. This pressure, on the inside, is the power that seizes an instrument when introduced, and carries it towards the pyloric orifice. The reason of food's leaving the second stomach immediately after death, is because the vacuum in the right heart is destroyed, and the nervous system has ceased to give a *vis a tergo*, or back force. Perhaps it may appear chimerical, to some, that pressure and vacuums could have an influence in the round from the mouth to the right heart; is this more surprising than the influence, on precisely the same principle, that carries the fluids from the roots of a tree into its branches and their subdivisions? and does this appear as difficult as that of carrying the blood through the whole system by the influence of the heart alone?

23. Now, the question arises why the arteries, being cones as well as the veins, if they sustain equal pressure on the outside, are not compressed? and why this pressure does not send the blood to their bases? It will be remembered that from the structure and contractions of the heart, a vacuum is maintained at the

base of the veins, which removes the pressure from the inner surface of these organs, this allows the external pressure to send the blood, because the pressure of the atmosphere is perpendicular to every surface, and this would give the lines of pressure towards the base of the cones; see fig. 5. The pressure on the outside of the arteries does not equal that on the veins, because that on the veins is increased by nervous influence, but did the same amount exist on the outside, it would be over-balanced by the force on the inner surface of these organs, together with the vacuums in the tubes; for illustration, we will suppose that the heart contracts with a power of four ounces, two of which are thrown on the pulmonary artery, and the other two on the aorta; this two ounce power, which acts on the bases of these organs, acts with equal force, on all parts of equal area, of the inner surface of the artery, and aorta, and this is why the internal force, prevents the external pressure from sending the blood towards the heart.

24. Now, it becomes evident, as all the blood vessels, both arteries and veins, are cones, with lines of press-

sure towards their bases or openings into the heart, and that the upper part of the heart takes the same form; also, that the blood has been removed from the ventricles by the last contraction, leaving vacuums; it becomes evident, I say, that this force on the outside increased by the reflex action, produced by the pressure of blood in the auricles, would cause the contraction to commence on the base or upper part of the heart first, contracting the auricles, and that these lines of pressure would be reversed on the apex of the heart, throwing the blood from the ventricles into the pulmonary artery and great aorta, indeed, it is these cross lines of pressure that run from the base towards the apex, and from the apex towards the base, that gives to the heart its power to contract, that is with the vacuums in the tubes of the lungs and skin (see Fig. 2). What terrible results would ensue to the delicate structure of the lungs and other organs of the body, were the heart to contract without vacuums ahead of it; this effect is shown in the lungs when the pressure becomes suddenly too great; as, in lifting; some might suppose that the pressure on the veins would send the blood from them, leaving vacuums, which would allow the heart to contract without injury to other organs; but we have seen that pressure cannot act without vacuums ahead of it, and there would be none in the heart, were there none at the lungs and skin; by saying that pressure could not act without vacuums, we mean that it could not act, under the circumstances, the circulatory system being full of blood; the condition would be precisely the same as to establish an extra amount of pressure at one point in the atmosphere with no less than the ordinary amount at any other, we at once see that the tendency would

be to throw this extra pressure equally in all directions, instead of establishing currents; and, now we cannot but see that so long as we refer all of the influence back to the heart, we have but one condition of power on which to depend for action; and that is the pressure on the heart produced from whatever cause it may be; if we refer this cause to atmospheric pressure, we have that alone for motive power, and if we refer it to muscular power of the heart produced by involuntary action, we are in an equal dilemma, and we cannot take them together, because atmospheric pressure will not act without vacuums; and if the heart contracts by the influence of the blood thrown upon it, we cannot make this contraction the cause of bringing the blood to it, unless accompanied by some other power; but if we establish vacuums in the tubes of the lungs and the skin on the principle of rarefaction of air by combustion, we shall have just as reliable ground for motive power as we have for the circulation of air; if the circulatory system would act without a power outside itself, we might dispense with the action of the skin, and also that of the lungs.

25. The repairing process of the system must take place on the inside of the coats of capillaries, because the blood flows there, and the worn-out or disengaged elements must be drawn to the outside of the capillaries; that is, a current of motion of elements is kept up from the inside of these organs to the outside by the demand made on them by the lymphatics, which are under the influence of pressure on the outside of cones, because the pressure is removed from the inside by the vacuum in the right heart; this, I consider to be the normal action of the capillaries in their renewal and repair; of course, it will not be supposed that all

materials will be indiscriminately drawn in to assist in creative assimilation, but that chemical action will make its selections as the secretory organs do when the current of life is presented to their lips through like influences. Some might suppose that the materials, drawn in for the repair of the capillaries, would leave vacuums that would draw the blood to them, but as the waste matter is taken to the heart in the lymphatics, the whole process is referred back to the right heart, and it becomes evident that it could make no difference, whether this amount of material was taken to the heart by the veins or the lymphatics so long as both are under the influence of this organ, and nothing is removed from circulation. But the condition is changed when the hydrocarbons are drawn out by an influence, established outside the circulatory system, as is done in the air tubes of the lungs and skin. It cannot possibly be considered a chimerical idea, that the draft, made by the lymphatics upon the capillaries, through the influence of the vacuum in the right heart, should be efficacious in bringing the elements of the blood through the coats of the capillaries, because the known facts that the coats of the capillary tubes are repaired by the blood on their insides and the absorption of disorganized elements from their outsides, is positive proof in the case; and, I, also, entertain no doubt, but the draft of the lymphatics upon the capillaries has its influence in bringing the blood from the main arteries to organs not directly connected to the air tubes of the skin; and it will be hereafter proved that not only the veins, but the lymphatics are the organs, through which, by the pressure on them in connection with the vacuum in the heart, that perform this office; but we must not forget that this

power is secondary, and would have no existence but for the capillary force sustained in the air tubes of the lungs; as, proof of this theory, remember that the capillaries do not make a draft on the lymphatics, but the lymphatics make theirs on the capillaries, and keep a current passing from the inside of these organs to their outsides; in returning the blood to the heart an advantage is gained by the veins being greater in number than the arteries, and, also, by having the assistance of lymphatics, that is the more surface under pressure in proportion to the weight to be moved, the more power is obtained.

26. As the capillaries constitute the organs through which the renewel of the system takes place, we must, of course, know that they contain arterial blood; to know that arterial blood fills the capillaries of the skin, remember their pink color when exposed to cold, unless the cold is sufficient to close the tube, and this congestion gives to them a blue color, and the slow circulation of the blood through the capillaries together with the absorption of disorganized material gives to the venous blood its dark color, but as refrangibility always affects color, various causes exist in different parts of the circulatory system for the difference in color, with which we meet.

27. In recrementitial absorption; as, fat, marrow, synovic of joints, etc., the action is the same as in cutaneous, except, this is from internal, instead of external surfaces; but all are dependant upon the vaccuum in the right heart for their motive power, as, also, are all secretions. Intersticial, recrementitial, cutaneous, and respiratory absorption, take place through the same class of organs, that is lymphatics;

and by the same power, the vacuum in the right heart; the venous and lacteal, also, take place through the same power, but not through the same organs.

28. Some, perhaps, might question whether the exceeding small cells in the lungs can contain an amount of hydrocarbons sufficient to sustain combustion to produce vacuums having power to call the blood from the capillaries through the influence which they create in the right heart, and to perform the great work of absorption of which we have just been speaking; although each cell furnishes a very small amount, yet, when taken together, they cover a surface of, at least, one hundred square feet, and it is their united power, which furnishes the force of which we have been speaking; and it must not be forgotten, in comprehending this influence exerted by the action in the lungs, that the force, which the heart exerts upon the base of the pulmonary ertery, is exerted upon every equal amount of surface on the inside of this artery, and on all of its branches.

29. Although the draft, made upon the capillaries, by the combustion in the air or perspiration tubes, which amount to millions on the surface of a person, when taken together with atmospheric pressure, and the influence of the great sympathetic, have power to cause the left ventricle of the heart to contract with such mighty force, yet, each tube, when taken alone, has but a small power, which is sufficient to call into it disorganized matter, but not to produce uncomfortable results. As the vacuums, which are formed by combustion, in the air tubes of the lungs, draw from the capillaries the hydrocarbons, this draft calls the blood into the vacuums, which they leave, and it be-

comes evident that the amount of these elements, removed frees the blood from its dark color; it will be remembered, also, in accounting for the difference of color in the veins and arteries, that the secretions, except in a few cases, as, liver and lungs, take place from the arterial system, thus, constantly freeing it from elements, suitable to be used in the system; and that on the contrary, the veins are continually gathering up disorganized elements.

30. Having stated my own theory, in the *main*, in relation to the motive power of the action that takes place in the human system; I think proper, before discussing other theories, to enter into an investigation in regard to the positions in the system, in which it is indispensible to establish vacuums, in order to promote equal circulation of the blood. And to possess ourselves with clear ideas on the subject we will suppose the body to be in a horizontal position, so that gravity will give nearly as much power on one part of the circulatory system as on another; and we will make three suppositions upon the circulation of the blood without changing the position of the body; first, we will suppose that there are no vacuums formed, either in the lungs, skin, secretions, excretions, or chemical work of the system, that is, there are no vacuums at the capillaries in any part of the body, if there are no vacuums, atmospheric pressure will balance itself so that no assistance can be gained from that source, consequently, the muscular power of the heart with the assistance of nervous influence on the veins, must lift the blood, through the whole circulatory system, by a *vis a tergo* or back force, against the the power of atmospheric pressure; we have,

already seen the difficulties that would attend action under these circumstances; notwithstanding these, we will allow the heart this power, by this hypothesis; and we will, also, suppose the organs throughout the system to be sufficiently firm to be in no danger of giving way by the pressure brought to bear upon them; thus circumstanced, with the circulatory system full of blood, we will suppose the heart to contract, the right ventricle throws the blood towards the lungs, and the left ventricle throws it into the aorta; the room in the right heart, left by its contraction, relieves pressure at that point, and the question is whether the blood will be lifted into this space from the shorter circulations; as, from capillaries of coronary arteries and capillaries of systemic circulation of the heart, or from the surface circulation; it appears not to require a moment's thought to see that it would be removed from the former, because the blood here is so much nearer the heart; but every contraction of the heart exerts an equal influence on all of the arteries, in proportion to their size, throughout the system, says one, as shown by the pulse; we are not speaking of what *does* take place, but of what *would* take place under the hypothesis in question; some might suppose that as soon as there was as much blood thrown upon the shorter circulations as they could receive, that it would then be thrown upon more distant routes, and so it would; but remember that, as the blood in the short circulations is so much nearer the heart, its motions would produce greater effect on it, and thus it would be sent with greater rapidity, and would tend to enter the space in the heart before the blood from more distant parts could be brought, and would force the heart into quicker beats, and the acceleration of

blood through these circulations, would produce congestion in these organs, while the more distant parts, would be left cold and unnourished; there can be no mistake in this principle, the simple question is, of two tubular circles filled with blood, and tangent or touching at the heart, with but one cavity to receive the blood, which is driven by the same power; through which of these circular tubes, one six inches in diameter, and the other four feet, could the blood be lifted with the greater ease? and, consequently, which would be sent most rapidly? Second, we will suppose that the exhalations at the lungs, and those at the surface of the body, produce vacuums, and, also, that the secretions, excretions, and chemical work of the system that takes place in the coats of the capillaries, do the same; that is, there exist vacuums at the extremities of all the arterial cones, which are the capillaries; now, it becomes evident, that as these different points have equal advantage, except in distance, the same as before, that the result would be the same, except, that in the latter case, the circulation would be more rapid, and in less danger of tearing up the circulatory organs, because in the latter case we have both a *vis a pronte*, and a *vis a tergo*; whereas, in the former we had but the *vis a tergo* alone; consequently, we see that, in in both cases, the blood would circulate with great inequality, flooding some parts, and leaving others cold and inactive. Third, we will suppose that the combustion sustained in the air tubes of the lungs and in those of the skin, produce vacuums, but that neither the ordinary chemical, nor secretory action of the system does; this condition would give to us reliable ground for general and equal circulation, because the motion of the blood, through all shorter circles, would

depend for one of its conditions upon the vacuum in the right heart, which depends upon those at the lungs, and for the other, it would depend upon contraction of the left ventricle of the heart, which depends upon the vacuums at the surface of the body, and being dependent upon these conditions for its motion, it could not exceed their rate of movement, except, for particular local causes; the chemical and secretory action in different parts of the system differ greatly in time, being very much slower in bone and cartilage than in many other parts; but, was there any part of the system, to which the blood was not sent with equal force, that part must, evidently, be defficient in supply; by the statement just made, I do not mean that the blood when first sent from the heart does not move faster than it does after it has reached more distant parts; but only mean that the capillaries where it is received and used have equal advantage; did not vacuums exist at the surface of the body, we should be constantly, in the condition that obtains when the pores of the skin are closed by the cold. Now if these things are as stated in the last hypothesis, and it is true that the left ventricle of the heart derives its power to contract through the influence of vacuums at the surface of the body, some may ask, by what power is the blood brought to the capillaries of the short circulations, there being no vacuums, by hypothesis, at these points. We have heretofore promised to show that this office is performed by pressure on the veins and lymphatics, in connection with the vacuum in the right heart; it is, of course, understood that the blood is sent, by the action of the heart, influenced by the vacuums at the surface of the body, in the aorta to points where branches leave to pass to short circulations, and that

the distance from these points to the said capillaries are very short, it must, also, be seen that the great vacuum in the right heart, which exerts an influence on the blood in the capillaries at the surface of the body, exerts a far greater influence on that, which is so much nearer; and that as the pressure on the veins and lymphatics, which are so near the vacuum in the heart, acts with such force; it can be seen that they really give to the capillaries of the short circulations the influence of vacuums to a certain amount; but this amount must depend on the vacuum in the right heart which depends upon those at the lungs, and, therefore, are regulated by that power. These shorter circulations depending on the pulmonic circulation, and upon the systemic circulation at the surface of the body for their control, constitutes a system of wheels, the work of which is like a wheel in the middle of a wheel; and this wheel, on which the others depend, rests upon the earth, or depends upon the action of the air. (Ezekiel, chap. 1.) This is a wheel worthy the attention of a divine or philosopher of any age, because the preservation of the life of a creature, in the image of God, depends upon keeping these wheels in order and ready to perform their office.

31. Among the different theories which are abroad for the circulation of blood, and, consequently, for the motive power of the human system, I shall think proper to make observations on but five of them; the first two, of which I shall speak, have for one part of their theory the hypothesis that the oxygen which enters the lungs in the air passes through the pores of the coats of the capillaries of the pulmonic circulation into the blood, rolling into these pores on one side as

the carbonic acid and vapor roll out on the other, after the manner of cold air rushing in at the bottom of a door while the warm air rushes out at the top of it, or after the manner of two wheels, which turn different ways by the same power; the first of these two theories, has for one part of its hypothesis, the idea that the oxygen, which enters the capillaries of the pulmonic circulation, is carried in the blood to the capillaries of the systemic circulation and there used in creative, and in destructive assimilation in the chemical changes, which take place in these organs, and that the products of destructive assimilation are taken up by the lymphatics and veins and carried to the right heart, and to the lungs where the carbonic acid and vapor is exhaled; this theory, also, holds the idea that the products of the chemical action, which takes place in the coats of the capillaries of the skin in destructive assimilation, are thrown into the perspiration tubes, and thus they are removed from the surface; and, further. it is thought by these theorists that the chemical action, spoken of, which takes place in the coats of the capillaries throughout the system forms vacuums, which allows the heart to contract without injuries to the system; that the chemical action of the system, except that, which takes place in the skin and in the lungs, has any power in forming vacuums, I have not been able to see; for the following reasons:—the first of these reasons is that no more creative than destructive assimilation takes place in these organs; the second, is that nothing is removed from circulation, but the products of this action are taken to the heart either in the veins or the lymphatics; the third, is that chemical action forms a part of the circulation, that is, atoms are deposited

and others are removed, the difference between chemical circulation and ordinary motion of the blood consisting in the fact, that the former takes place slower than the latter; and the fourth is that the ordinary chemical action of the system, depends upon the chemical action at the surface of the body, and that in the lungs, together with the heart, to bring the blood within the range of chemical affinity, as well as secretory action; and the range of chemical affinity, proper, will be hereafter shown not to exceed the size of the particles, so that they must be brought in actual contact before this work can take place; if this chemical action at the surface, and at the lungs are not indispensible, why the serious consequence that immediately follow inaction at either of these points? And now we will investigate a little the action that is, by this theory, supposed to take place at the surface of the body; by this, it is concluded that the products of the chemical action, which takes place in the coats of the capillaries of the skin, are thrown into the perspiration tubes and exhaled; that the products, of which we have been speaking, are thrown into the tubes mentioned when sensible perspiration obtains so that the coats of the capillaries and those of the tubes are both dilated and, consequently admit a free passage between them, there can be no doubt; but we may remember that an extensive lymphatic system is provided for conducting the waste products from the capillaries of the skin, under ordinary circumstances, and the small amount of these elements, which are exuded from the extreme upper surface of these capillaries, and from the oil glands, where lymphatics cannot touch them, are those which form the cuticle, and thus prevent a great amount from being exhaled

from the capillaries if it could be shown that the products of the action, which takes place in the capillaries are commonly thrown into the perspiration tubes; this, alone, would give to us reliable ground for a certain amount of vacuums at the surface of the body, because, virtually this action is outside the current of blood and makes removals from it; consequently whenever these products are thrown into the tubes, they must, of course, produce this effect, and the small amount that exudes from the surface, cannot possibly fail to form a certain amount of vacuum at these points, and this is the influence, I conclude, which brings the blood from the small arteries, which lead off to form the capillary net work of the skin; but this influence could not act with any great force on the muscles, which lie under the adipose tissues, and which are so far from the heart that its vacuum could not easily affect them, and the difficulties of throwing the products of the action in the coats of these capillaries, through the adipose tissues into the follicles of the perspiration tubes, against the influence of the lymphatics, forms one of the strongest arguments in favor of the combustion of hydrocarbon vapor in the tubes. Although sensible perspiration together with the pressure of the system, assists circulation when combustion is suspended in the tubes, yet, this is an abnormal condition, and is attended with uncomfortable sensations, which, however, are better than that which would obtain, under the circumstances, did not this abnormal action take place, and the relief given by this action, sometimes leads us to conclude that sensible perspiration is a normal action of the system; but if we are to depend entirely upon casualties for the circulation of

the blood, we had better at least, endeavor to have them occur as regularly as possible. Instead of the chemical action, that takes place in the coats of the capillaries, where no removals are made, having any tendency to form vacuums, I conclude that it retards the motion of the blood, by arresting materials, and would bring it to a stand, were not that influence counteracted by combustion where removals take place. The slow motion of the blood through the capillaries has led me to suppose that the fibrine and globules, might take their form in these organs.

32. If we could possibly satisfy ourselves that the chemical action which takes place in the capillaries of the skin would possess sufficient influence in forming vacuums to allow the heart to contract with a force that would send the blood through the aorta and its branches, this theory of chemical action could have no possible influence in bringing the blood through the pulmonary artery, because the blood is not sent in this organ to repair capillaries, but is sent, it is said, to throw off carbonic acid; the office of the systemic blood vessels is to repair capillaries—here the theory utterly fails, unless we suppose that the small amount of chemical action, which takes place in the repair of the capillaries of the pulmonic circulation, performs this office, and stands as a balance to the action, which takes place in the capillaries of all of the surface of the system, bringing the blood back from all the other circulations; and if it does, it must be forming rapid changes—that is, these capillaries must be undergoing these changes, which would produce a very unstable condition, and unfit them for the reception of the great amount of blood, which is constantly flowing

through them; and if there is an amount of combustion taking place in the coats of these capillaries which is sufficient to produce the carbonic acid exhaled at the lungs, the blood in them ought to be warmer than that in the rest of the system, which has been found not to be the case. Can we suppose that the products of the chemical action in the capillaries of the pulmonic circulation would not be taken up by the lymphatics and carried to the right heart, as is done in repair of all other capillaries? With the foregoing theory some authors connect the idea that the enlargement of the chest in breathing forms a vacuum, that has an influence in bringing the blood to the heart; I have not been able to learn that any vacuum is produced by the enlargement of the chest, because it is enlarged no more and no faster than the entrance of air into the tubes enlarges it; that is, the force that enlarges fills the enlargement, and that force is the air pressing on the pneumogastrics; but was a vacuum produced in the chest by this cause, the effect would be directly contrary to that which it has been supposed to be, because said vacuum would destroy the pressure on the outside of the veins after their entry into the thorax; the action of the muscles, although they greatly assist the circulation, cannot be relied upon, having no regularity. On the supposition that the oxygen, which enters the tubes of the lungs goes to support combustion in the capillaries of the pulmonic circulation, it could have no influence in changing the color of the blood in the arterial system because it is not taken to the capillaries; and on the supposition that it is carried to the capillaries, rolling in on one side of the pores as carbonic acid rolls out on the other, no vacuum would be produced because nothing

is removed only as its place is instantly supplied by another element, of which more is received than the carbonic acid removed; if this action would produce vacuum, we might place a wheel in the tops of our pumps and turn the water out; in the Vegetable Kingdom we found that evaporation is necessary to carry the fluids up, and that gravitation acts to bring them in an opposite direction; if there exists in the chemical action of the capillaries of the skin some influence that calls the blood to the surface of the body, I would ask what influence takes it back to the lungs? The heart cannot send the blood until it arrives at that organ, and the pressure on the veins and lymphatics will not act without a vacuum at the heart, and none would exist there, unless some existed at the lungs. Now let us endeavor to look this theory, of vacuums at the surface of the body without any at the lungs, square in the face, and listen to the language which it utters,—these are its statements: I have vacuums established at the capillaries over the whole surface of the body, and such is the peculiar character of the vacuums that exist in these organs that they exert at *one* extremity of these capillaries an influence, which gives to the left ventrical of the heart power to contract with force sufficient to send the blood to the extremities where these influences exist, and the vacuum, formed in the left heart, by this action, calls the blood from the lungs; but at the *other* extremity of these capillaries, the vacuums in them become so perfectly inactive that they allow the pressure on the veins and lymphatics to send the blood from them to the right heart against atmospheric pressure, because there is no vacuum at the heart, there being none at the lungs, and the right heart, understanding that it

is necessary to have carbonic acid exhaled at the lungs decides to send the blood to these organs against the pressure of air, which, according to this hypothesis, always exists in the air cells of the lungs; but some, perhaps, may think that the premises have not been fairly stated, because the arrangement of the hearts are such that the contraction of the left ventricle forms a vacuum that acts to produce one at the lungs, and this with the contraction of the right side of the heart forms one in this organ, and thus the influence at one extremity of the capillaries is exerted through the whole circulation around to the other extremities, while these remain entirely inactive; the difference between these two premises is that in the first the active extremities exert their influence only to the lungs, while in the second it is exerted from one of these points entirely around to the other, but in both of these hypotheses one of these extremities are wholly inactive; it is easy to see how the left heart, influenced by vacuums at the surface of the body, could so organize itself as to be able to send the blood to the capillaries of the systemic circulation, on the principle that a tree sends out its branches; but to understand how the right heart, uninfluenced by vacuums at the lungs, could make arrangements to send the blood to these organs, in opposition to the influence exerted upon it by the vacuums at the surface of the body and the pressure of air at the lungs, is not so easily seen. Now, in view of these considerations, is it not reasonable to suppose that the Great Architect of the Universe, in making his arrangements for the organization of man, ordered the blood, when it reached the capillaries of the systemic circulation, to wheel, by establishing at the lungs an influence that

would enable it to do so, and that He gave to it the same command when it reached the capillaries of the pulmonic circulation by establishing at the surface an influence that would enable it to do likewise.

33. It will be noticed that, although Cell Formation requires vacuums to carry fluids, both in the Animal and in the Vegetable Life, yet they are produced in a different way, being formed in the vegetable by evaporation simply, and in the animal by combustion. It will be seen that there exists a wider difference in the results of these operations than might at first be supposed; the evaporation simply calls the fluids where they are needed, while the vacuums formed by combustion keep up a rapid circulation through the system, thus affording a great amount of heat, generated by the friction which the rapid motion produces; this shows why animals are warm in an atmosphere that will freeze vegetables; animals whose circulation is slow are cold-blooded in proportion to that action, as fish and reptiles; it also accounts for the connection that exists between respiration and heat in all of the Animal Kingdom.

34. In order to obtain further satisfaction in regard to the action that takes place in the lungs and in the perspiration tubes, we will examine a case of ague-fever; the first phenomenon that presents itself is a chill, the cause of which, I conclude, is owing to the low state of combustion in the tubes, produced commonly by the extinguishing character of carbonic acid, this condition disables the system in circulation and produces the chill—that is, the system becomes cold for want of action; as circulation produces the heat, the want of it causes the chill; the blood becomes,

congested in the short circulations, and withdrawn from the more remote, and instead of the assimilation that should take place in the coats of the capillaries, the destructive assimilation is increased, which is produced in the short circulations by congestion, and in the remote for want of elements to use; this condition produces the fever, and when this has continued for a sufficient length of time to clear away the obstructions the dilitation of the system by heat throws open the perspiration tubes and produces sweating; this action, although it is an abnormal one for a person in health, is, nevertheless, the best that could take place under the circumstances, because it removes a large part of the material that has been produced by destructive assimilation; the relief produced in such cases leads us to suppose that this is a normal action of the system, whereas, the small amount exhaled from the tubes in health and under comfortable circumstances, and that in the form of vapor and carbonic acid, gives evidence that it cannot be considered in that light. This theory accounts satisfactorily for the ague chills that always catch people, apparently in health, so soon after entering districts infected with carbonic acid; that is, the acid extinguishes the combustion.

35. Although a want of air on the skin does not produce death as soon as a want of it in the lungs, yet it is equally sure, as death always takes place when the skin on the entire surface of the body becomes disorganized; this fact, together with the suffocating sensation experienced when the air is excluded from the skin, gives evidence that the influence of this gas on the skin is indispensible to life. Now a question arises, whether the air goes to sustain com-

bustion in the tubes, or is received into the capillaries, rolling in on one side of the tubes as the vapor and carbonic acid roll out on the other; the difference in these results are of the most momentous character, because if the air merely enters the tubes to sustain combustion it is evident that vacuums are continually formed at these points by the removal of the hydrocarbons, whereas, if as much oxygen enters on one side as there is carbonic acid and vapor passes out on the other side of these tubes, as it has been supposed to do in the lungs, it is evident that no vacuums would be formed, because nothing is removed, only as its place is that instant supplied with other materials; this we have heretofore seen to be incapable of producing vacuums. Now what becomes of the theory of producing vacuums by throwing the products of the chemical action that takes place in the coats of the capillaries of the skin into the perspiration tubes, under ordinary circumstances? That this action would form no vacuum is placed beyond a doubt, but when sensible perspiration is thrown into these tubes of course no oxygen enters, and then this action assists in forming vacuums.

36. I would not object to this theory of rolling in on one side of the tubes and out on the other, after the manner of two wheels which turn different ways by the same power, if this process would account for the phenomena of the system, but it does not; and if a small amount of oxygen does enter the capillaries of the pulmonic circulation, and the carbonic acid generated by congestion of the blood passes out, it is evident that it must take place in that way; this I suppose to be the case, there being a superabundance at

some times in the blood; the odor of the breath is evidence that such products are at some times exhaled.

37. A question might be asked, Why, if combustion in the perspiration tubes is so essential to circulation, does not death immediately follow the disorganization of the skin from any cause? So long as the action of the lungs remains unimpaired, the vacuum in the right heart will be produced, this will call the blood from the capillaries and fluid from the lymphatics; this influence, together with the imperfect vacuum in the left heart, will call the blood slowly from the lungs for a time and bring it through the shorter circulations, producing congestion in these organs.

38. To understand precisely the phenomena that take place, the conditions that obtain in case of colds, is of the highest importance to every individual. When a person is sweating profusely, combustion in the perspiration tubes is not taking place, the follicles are filled with fluid, in this condition, if the pores are suddenly closed by cold, the fluid remains in the follicles, and combustion cannot be resumed, hence the cold skin; and when the system is in a natural state and the tubes are closed by cold, the shutting off of the external air sends the fluid into the follicles, and the same conditions finally obtain under whatever circumstances the cold is contracted. It will be seen that the great object to be attained is to remove the fluid from the follicles, so that combustion may be resumed in the tubes. Bathing in anything that will open the tubes, setting the feet in warm water, and the whole body, in extreme cases, are of course the remedies for the skin; and this, in most cases, is sufficient when a cold is first taken; but if of longer stand-

ing, internal remedies must be used in connection with those of the skin—diaphoretics I have found to be most reliable; but as my knowledge of medicine is very limited, others equally good may exist. In some cases when a cold is contracted a general fever immediately sets in, this is occasioned by obstructions of malarious matter previously existing in the system, hence the sad results that commonly attend a cold received under these circumstances; in this case not only attention to the skin is requisite, but remedies to remove bilious difficulties are essential. Here a question arises as to what keeps up the circulation when combustion and sensible perspiration are both suspended in the tubes. It is evident that as the circulatory system is a connected round, and the circulation established in one direction and prevented by the valves from returning, that so long as vacuums are formed at the lungs an imperfect circulation would be kept up; but the blood, acted upon only by vacuums at one point, would seek the nearest route to return, and would leave the capillaries of the skin with but little blood, and the circulation generally would be slow and imperfect, hence the chills that always attend a cold, except in case of being accompanied by fever, and even then the chill sometimes makes its appearance for a short time.

39. It will be remembered that statement has been made that there were two theories for circulation having the same hypothesis for the action of oxygen and carbonic acid at the lungs; and having finished our discussion of the first, we will enter upon the second. One part of the hypothesis connected with this theory is that the oxygen, which, according to this view, en-

ters into the pulmonic circulation, has so powerful an affinity for the tissues composing the capillaries that it drives the blood before it, and, of course, that its influence is neutralized by uniting with the elements which compose these tissues, and further, that the force bestowed upon the arterial blood by this influence, enables it by a *vis a tergo* or back force exerted inside the veins to lift the blood from the extremities of the arteries to the heart against the influence of atmospheric pressure, because there is no vacuum at the heart, there being none at the lungs; that chemical influence proper can exert an influence at a distance will be hereafter shown to be impossible, as has already been stated; but chemical action, by making removals, brings in gravitating forces that act when these removals are not instantly replaced; now, should we establish two forces in a certain locality, one of which should be engaged in forming chemical unions and the other in forming disunions of the same elements, I should be unable to see how this locality could influence others. Notwithstanding what has been said on this subject, we will allow to the oxygen the power claimed for it, for the sake of following up this theory, and learning how it can make out the remainder of its hypothesis. We will suppose the arterial blood to commence its influence on the venous blood, and the venous blood to have arrived at the mouth of the thoracic duct and lymphatics, except the valves, which have been formed by the current, nothing would exist to prevent its entry into these organs, because there is no arterial blood behind these fluids, and no vacuums ahead; the want of vacuums at the lungs would cut off the power of the system in absorption, and this with the absence of them at the surface

would cut off its power in secretion; but suppose that the blood did reach the heart, as no vacuums exist at the lungs, the muscular power of the heart must act unaided, because there are no vacuums ahead of it, and no arterial blood back of it; but arriving at the lungs it receives its new impetus of oxygen, and sets out on its journey of harmonious action, by hypothesis.

40. If combustion takes place inside the capillaries, as this theory supposes, how can we account for coldness of the skin when the perspiration tubes are closed? and, on this theory, how can we account for the decrease in venous blood, on reaching the lungs, if the carbonic acid is exchanged for an equal amount of oxygen?

41. Although I cannot suppose that the main action in forming carbonic acid takes place inside the capillaries, yet I feel certain that when these organs become obstructed so that fluids cannot pass, the heat which is ever present in them would produce slow combustion, and the offensive odor of the breath, in case of fever, gives evidence that some of the gas is exhaled at the lungs. I also deem it possible, from the fact that more oxygen is received than carbonic acid exhaled, that some of it may unite with iron, as some authors suppose, and influence the color, at least I know of no reasoning against it.

42. An objection has been raised to the theory that combustion takes place in the air tubes of the lungs and those of the skin on the ground that a frog, breathing pure hydrogen, continued to exhale carbonic acid during seven hours; the circulation in these creatures is so very slow that it does not appear to me to be

more singular that a frog should live seven hours without oxygen than that we should live seven minutes without it; their capacity of remaining so long in a torpid state, gives evidence of the small amount of oxygen required for their existence; and the displacing power of hydrogen accounts, satisfactorily, for the carbonic acid exhaled.

43. It is stated that if fresh blood from the veins be suspended in a membrane, the blood, next the membrane, will change from a dark color to a light red; and that if venous blood be agitated in the air, all of it will change to a light red; the pressure of the atmosphere would send some parts next the membrane through it, and some oxygen might enter; but if the oxygen had the power to follow up the carbon that, by one theory, it has been supposed to possess, it appears to me that it would penetrate all parts of the blood in the membrane, and uniting with the carbon would throw it out; and as refrangibility is the basis of colors, and the blood at the center of the membrane is in a more quiescent state than that at the surface, it would be affected by this cause.

44. There are several reasons brought up, by some, for believing that the oxygen enters the air cells, as they are called, of the lungs, and one is that they can be inflated when removed from the body; but I do not see this to be proof, because various other organs can be inflated with air; the main air tubes of the lungs are, of course, inflated at every breath; another is the idea of the grossness of combustion in the tubes, this notion, probably, obtains, in consequence of not realizing the small amount, required at any one tube at the same time; a correct idea on this subject can be

obtained by taking into consideration the amount of fluid which can possibly be removed at one moment from the top cell of a tree four hundred feet in height, and that this small removal, influenced by capillary force, has power in connection with atmospheric pressure to lift the fluid in this whole column of cells from the ground up a certain distance; the want of a knowledge of capillary force has always stood directly in the way of a proper understanding of circulation of blood. Certainly if there are any places in the system where vacuums could be formed with ease and advantage, it would be in the air tubes of the lungs and in those of the skin. I should not know how to comprehend Cell Formation without a *vis a pronte*, as well as a *vis a tergo*, because the blood thrown upon them by the *vis a tergo* or back force alone could not possibly prepare and raise the film for the cell.

45. There is one more possible theory in relation to the action that takes place in the lungs, and that is that the carbonic acid is exhaled from the capillaries of the pulmonic circulation, and the oxygen enters either into the capillaries of the systemic circulation or into their tissues; in either case the work of the oxygen would lie between the lungs and the right heart, because, did it enter the capillaries, it would be taken in the veins of the systemic circulation of the lungs to the right heart; and did it enter their tissues it would be taken up by the lymphatics and carried to the right heart; and the oxygen which enters the perspiration tubes would also be carried to the right heart through either veins or lymphatics.

46. It is claimed by this theory that as carbonic acid is exhaled from the pulmonic circulation, and nothing

is received into it, that this forms the vacuum that calls the blood; this theory is preferable on this subject to the former two, because in those nothing is removed except as its place is filled at the moment of removal by another element; but I am unable to see that the bare discharge of material when brought to a certain point by a back force has anything to do in forming a vacuum to bring it there, although it would leave space into which elements could enter when brought there by another force; if it could, we might point the hose of a fire engine on a burning building and no forcing pumps would be required, and vegetation would grow as well without evaporation as it would with it; under the supposition that oxygen enters the capillaries of the systemic circulation or their tissues, it could have no influence in changing the color of the blood in tne pulmonic vein or in the aorta, because it does not enter that circulation until taken to the right heart.

47. All of the experiments in relation to the mingling of carbonic acid and atmospheric air, with which I am acquainted, take place on the ground of the greater weight of the acid, in connection with atmospheric pressure, the acid always showing a reluctance to mingle, except when placed higher than the contiguous air; therefore I am unable to see what influence it could possibly possess, in forming vacuums, by being thrown from the lungs. In connection with this theory, it is claimed that the combustion which takes place in the coats of the capillaries, connected with the aorta and its branches, generates an amount of heat that influences the motion of the blood; as this heat is constantly generated in the coats of all the

capillaries forming all the blood vessels, great as well as small, and as this action is taking place back of the blood as well as ahead of it, I am unable to comprehend this power. Also, in connection with this theory, it is claimed that the secretions and excretions of the system, by which elements are removed from direct circulation, holds its influence in forming vacuums; I can see how these removals, in both cases, leave room into which the elements furnished by food and drink can pass, but as there is no draft on these changes, except what is made by the vacuums at the surface of the body and that in the heart which depends upon the lungs, I am unable to see their power in producing the effect supposed; their influence in this respect is precisely like that of throwning carbonic acid from the lungs.

48. Another view, or theory, taken by some in regard to the circulation of the blood, is that the whole system is under pressure; and of course it is; but so much has already been said in relation to pressure without vacuums that I deem it unnecessary to say much on the subject. Atmospheric pressure, in connection with dilitation, produced by heat, is the cause of sensible perspiration, which, under certain circumstances, assists in forming vacuums at the surface of the body, as has already been seen; but if we are to depend upon casualties for the circulation of blood through the system, we must be in a precarious condition. Were we to suppose that the muscular power of the heart, assisted by exhalation, could carry the blood through the whole of the circulatory system without vacuums, there would be such an amount of the phenomena of the body for which we could not

account that it is not probable that any one who had fully investigated could long be satisfied with the conclusions.

49. Another theory for circulation of the blood, is that the nervous system performs the whole of the work, and this is really the king of theories, because it is through its influence that the organization has become such as to render it possible for the circulation to take place, because it is the mind that organizes the body and not the body the mind; the fish does not determine to walk on water, but arranges fins for swimming; it does not attempt to breath water with lungs, but arranges gills for that purpose; can we suppose that the more intelligent mind of man will seek to act contrary to the element in which he exists, or will he adapt his organs to receive the benefit of its laws? It will be seen hereafter that I do not dispute the influence of the nerves on the heart, and, equally, on all other parts of the system, so far as the arrangements allow of its action, but I do dispute its power to send the blood against atmospheric pressure, or to perform many other functions of the system without the aid of vacuums and atmospheric pressure. The theory of nervous action without vacuums, in results, would correspond with that of pressure without them, so that the two last mentioned theories may be considered as nearly the same in results, as will be hereafter seen.

50. In order to sum up the evidences belonging to the theory of this work on circulation of the blood, I will make observations on a few subjects which have not been fully discussed in the preceding pages.

51. First, as about one-fifth of all the food which

we receive consists of oleaginous substances, I cannot see the use that is made of them upon any other theory, especially as they are always found, except in the bile and brain, uncombined with other elements; the large amount of these elements which are constantly received, with the small additions which are made to the adipose of the system, filled my mind with enquiry before I investigated this theory; and from the statements of all investigators with which I am acquainted, they are merely mechanically deposited without being chemically combined with other elements, except in the cases before mentioned, and there in small quantities. Their light specific gravity is, undoubtedly, the cause of their being deposited on the surface of organs. Further it will be remembered that the digestion of oleaginous substances are effected through the assistance of pancreatic juice, and that this juice contains phosphate of soda, and sulphate of soda and of potassa, and it appears to me highly probable that these elements have something to do in preparing the oleaginous substances for combustion. It is stated by some authors that when a small amount of oleaginous substances are received in the food, that it can be traced through the thoracic duct, in a state of emulsion, and through the veins, heart, and pulmonary artery to the lungs, where it entirely disappears, and when a large amount of these substances are received a certain portion of them disappears at each circuit through the lungs until they are all removed from the blood. Now a question arises as to the manner in which these elements undergo change; can it be supposed that the oxygen which enters the lungs unites with these elements and converts them into sugar? If it does it cannot be taken to the capillaries in the

blood; or does the oxygen received at the lungs change the oleaginous substances into the albuminous group? It could not do this without the addition of nitrogen. It seems to be a law in the Animal Kingdom that the appetite calls for the precise combination of elements in food which the system at the time requires; and on this principle how can we account for the imperious demand made by the appetite, in the north, for food containing oleaginous substances? How can we account for our own in cold weather? And how can we account for that of consumptives in the last stages of the disease? The sensation of hunger cannot be produced by the want of materials in the blood; were that the case it could not issue so powerful a command in so short a time, because the materials in the blood would not be exhausted, but the relish for particular kinds of food must be produced by their want in the system, and this want would exist in the stomach, of which we would be informed by the nervous system. Chyle granules of oil are dark in color; this probably has an influence in the color of venous blood, and it appears to me that as the specific heat of hydrocarbon vapor is so low, it may not be impossible that some of that may be produced in the system; this would fully account for the color of the venous blood. And as further proof that combustion takes place in the tubes of the lungs, remember that if it does not we have the full force of atmospheric pressure continually resting on the capillaries at the lungs, and that this influence, instead of giving the assistance of capillary force, would reverse this action and stand antagonistic to the influence exerted by the heart on the pulmonary artery.

52. Second, when we become accustomed to any

idea it is difficult for us to change, even in the face of positive testimony; we have become accustomed to the notion that the blood requires oxygen to assist in the chemical work that takes place in the capillaries. Had we not better enquire into the nature of this supposed call for oxygen? Sugar must lose oxygen to become oleaginous, and as it is known that sugar used in food produces adipose, here is one instance where oxygen is set free; the albuminous group must lose oxygen to become oleaginous, and as it is known that they become decomposed before leaving the system, here is another source of oxygen; in forming pure hydrocarbons all of the oxygen is set free; one hundred and forty-four atoms of carbonic acid, and ninety-eight of water, must lose their oxygen to form one atom of stearine, and but little less to form any of the oleaginous group; to form one atom of stearine 326 atoms of oxygen would be set free; but I am really well satisfied of no so great call for this element above what is received in the food. But it is believed that carbonic acid cannot be decomposed in the body, and I do not know that it can; but certain considerations have led me to question the subject. I have never been able to form an idea of chemical action without mechanical force of some character; and the amount of mechanical force which will form a combination of elements will also decompose them, if applied with equal ingenuity; but a child might place together pieces of iron which would require immense power to separate them, if not applied in the right way. Carbonic acid is formed in the atmosphere by the influence of heat, and it is also decomposed there by the influence of the same power; it is formed in the body by the influence of heat, and the question is whether

it may be decomposed there; that formed in the lungs and skin is of course exhaled, but that formed in the body in its ordinary chemical work constitutes another case.

53. Third, it is stated by some authors that the amount of oxygen and carbonic acid which exists in the venous blood, and the amount of each which exists in the arterial blood, is proof of the interchange of these gases at the lungs; according to these statements, should the blood, while passing the lungs, receive 3-7 as much oxygen as it already contains, and lose 3-28 of the carbonic acid, which it contains as venous blood, it would then have its proportion of these elements, found in arterial blood; it is also stated by authors that 16 per cent. of all the oxygen which is received at the lungs, disappears in the blood, beside that which returns under the form of carbonic acid; authors differ so widely in the last statement, owing probably to different circumstances under which the experiment is made, that I have thought proper to take the average of those in my possession; if we know how much oxygen was received into the blood at each inspiration and how much existed there before; and the amount of carbonic acid which exists in the venous blood, and the amount of this gas which exists in the arterial blood; we could, then, see for ourselves whether the statements corresponded; but instead of the amount of these gases which exist in the venous and the arterial blood, we have given to us; so far as I know, only their proportions.

54. That so large an amount of oxygen as has been supposed is called for in the chemical work of the system, besides that of the lungs and skin, has already

been called in question; and that so large an amount of carbonic acid, as has been supposed, is produced in the chemical work of the system besides that at the lungs and skin, I am equally inclined to question, and further that some of this gas may be decomposed at the lungs by the influence of the action that produces vacuums, the same as is done in vegetation; that some of it may be decomposed in the brain forming cholesterine; that some of it may be decomposed in the liver and that some of it may be eliminated through this organ, are processes that appear highly probable from the view which I have taken of them.

55. Fourth, that tissues, when removed from the body, will receive oxygen and emit carbonic acid, is judged to furnish proof of the interchange of these gases at the lungs; the tissues, when in the body, are, of course, undergoing constant change, both by creative and also by destructive assimilation; but out of the body destructive action only of this kind can take place, and this would require oxygen and emit carbonic acid.

56. Fifth, in favor of the theory that contractions of the heart and respiration are produced entirely through nervous influence, is brought the phenomenon of the contractions of the heart of a frog when removed from the body; by that property of bodies, which has been known under the name of *inertia*, all bodies in motion tend to continue that motion after the motive power is removed; the reason of this is that when motion has been established in a certain direction, the electricity of that body is moving in that current, and it requires a short time to change; the electricity is not only moving through the nerves of

the heart, but it is accompanying the blood in the vessels of the heart, that is in the auricles and ventricles, as well as in the systemic circulation of this organ, and this motion is precisely the one to produce contractions; but the heart cannot contract in this case in consequence of the pressure of blood thrown upon it, because there is no blood in it, or if there was, the turning of the base down, as in the experiment, would allow it to run out and facilitate contraction; but its contracting when the blood is running out of it, would be no evidence that it could contract by nervous influence alone when filled with blood, much less that it could keep up these contractions for a life time and remain in an unimpaired state; now if contractions of the heart are influenced both by atmospheric pressure and nervous reflex action, a question arises how it is that these act precisely together; it will be clearly seen hereafter, by explanations which will be given, that the pressure lies back of the heart as soon as the contraction has taken place, but the moment the blood enters the heart again the atmospheric pressure acts with redoubled force, and this pressure on the nerves produces their reflex action, and thus their concert power is effected.

57. It must be seen that I did not get up this theory of circulation by pressure and vacuums with my own peculiar ingenuity, but that I have been driven upon it for want of some other on which I could depend; indeed, it was not until I saw the absolute necessity of vacuums to Cell Formation that I began to investigate in earnest the arrangements for forming them. Now, without any speculation as to the possibility of the amount of pressure brought to bear through the influ-

ence of the nerves on the heart and on the veins, I would ask what office *does* the skin perform in circulation that renders its action indispensable in carrying the blood through the system? Does it form vacuums by evaporation? This is done in the vegetable, and when the atmosphere is in a condition that will not allow this to take place vegetation is shorn of its foliage; but animals enjoy health in such an atmosphere. Can it be that evaporation forms vacuums on their surfaces? And if it did would not that influence produce cold instead of heat? What does it produce on us in warm weather? How can animals endure such changes of climate uninjured? What becomes of this theory of evaporation when the atmosphere is so damp or so cold that it cannot take place? Observation has shown that a suitable state of the air, both as to heat and moisture, are favorable to proper action of the lungs and skin; but the varieties of climate are too great to suppose that animal life must depend upon their casualties.

CHAPTER IV.

Exposition of Animal Cell Formation.

1. As all the organs of Animal Life are composed of cells, it follows that Cell Formation is the first step in Animal Organization; any amount of evidence might be adduced to show that this formation takes place through the influence of vacuums produced by heat, and this, together with the resemblance which they bear to vegetable cells, is proof of the analogy which exists between them.

2. A few observations on the Areolar and Mucous tissues will, perhaps, show more fully the analogy existing between Animal and Vegetable Cells. Under the head of Areolar Tissue, may, I judge, with propriety be classed the Cellular, the Serous, the Dermoid, the Fibrous, and the Muscular Tissues, that is so far as pertains to their formation, because they all consist of fibres originally formed in the Spheroidal cells.

3. Commencing with the Cellular Tissue that covers a muscle, we find its fibres commencing at every point of the compass, and crossing each other at every angle in direct lines from their point of origin, and thus continuing from layer to layer until they constitute a firm though flexible tissue. The cause of this manner of formation is, I conclude, owing to the fact that the heat and evaporation are general over the whole surface of the muscle; this causes the cells to start from every point of compass, and of course they must continue in a straight line as they form in Spheroidals.

4. In the Serous Tissue, which lines the chest, abdomen, and joints, I do not remember to have read a statement of the manner in which the fibers run; my notion is that they cross each other in angles, but they have received so many deposits in their completion that I presume it would be difficult to learn.

5. In the Dermoid Tissue, or skin, they appear to have started on the same principle as the cellular, both arteries and nerves, that is they run in every point of compass, but on arriving at the extreme surface they are, by their exuding and the pressure on the veins, brought into action by the nerves, and the vacuum at the heart, effected by those at the lungs, turned back.

6. In the fibrous tissue, or that which lines the

skull, invests the bones and forms ligaments and tendons, the fibres are found longitudinal and parallel with each other, forming plates; this formation must be due to two causes, one is that the heat by which they are influenced comes from one direction only, and the other is because they are confined within certain limits as are the leaves in vegetation.

7. In the muscular tissue, where we find the fibres longitudinal, but not in parallel plates, the heat must act in a particular direction, but the confinement must be of a different character.

8. It is evident, where the cells are injured merely by wear, that the circulation of blood through the parts would deposit the particles required, that is, chemical action playing its part; but where cells are removed by injuries or disease, so as to leave an opening in the filaments, the force of capillary power would be destroyed in the filaments so injured, because they would not be connected with the vacuums at the extremities; but it is evident that fluids would be brought near the dissevered ends by the draft on other filaments, because the general connection of these organs through pores on their sides would allow this draft; but the vacuums at the end would be formed by the heat, that is the film for the cell would be raised by the heat always present in the capillaries; and the cells form, in repairing, on a principle precisely analagous to that in the Vegetable Kingdom, and on the same principle that the cells of Animal Life first form; an egg, for instance, must be kept sufficiently warm to allow evaporation to take place through the shell.

9. On two occasions I have witnessed these cells in the formation of muscle removed, and beheld them

with the naked eye, but did not know at the time what to make of them; they resembled a layer of fine balls on an uneven surface, and were about the size that could be formed by cutting a very fine needle into pieces and rounding the pieces.

10. The first time I beheld this phenomenon it was on a man, from whom a large quantity of muscle had been removed from one of his ankles by an abcess, formed in consequence of a cut received several years before; the limb appeared to be tender, and required to be kept very warm by wrappings; this sore was on one of my father's hired men, and I saw the phenomenon in question just after it had been washed in soap suds.

11. The second was on my own hand, from which a small piece of muscle had been removed by a cut; at this time I do not remember to have seen more than five or six of these cells, but they had precisely the appearance of the ones which I had seen before. I attempted to wipe them with a wet cloth, but hurt myself in doing so, and did not succeed in removing them.

12. The arteries must, necessarily, commence their formation at the points where they enter the heart: they form under the influence of vacuums at the surface produced by heat, and when first formed are, of course, a simple line of cells, and as the evaporation at the surface continues to increase, new lines of cells start from the first, and from these others arise; meantime the increasing demand made on the first line of cells by the vacuums draws into it an amount of blood which increases its size, and thus the main arteries are formed; the inner tunic of the arteries is, of course,

formed by chemical additions from the blood to the inner surface of the first line of cells, and continue to form as these organs increase in size; the muscular coat of the arteries must start out at the heart on the outside of these organs in consequence of their distention in size, forming pores from which they can take rise, and they form in a spiral direction because they are influenced by two forces, namely, the vacuums at the surface and the pressure on the surface of the arteries; when these first form they undoubtedly form in the common size of the first line, but as the arteries increase in size a tension is brought to bear on these spiral lines which decreases their size in diameter; the cell lines composing the areolar tissue of the arteries is, of course, formed the same as cellular tissue already described; the reason, I conclude, for the middle coat of the arteries being elastic is that they are under the influence of the action of the heart in their formation as well as ever after.

13. The capillaries are a continued extension of the first line of cells from the heart, and the veins are a continuation of these; now, as the capillaries lie in every part of every organ of the body, and the veins, which arise from all these different points in different organs, are under the influence of the vacuums at the heart and pressure on their outer surfaces, they are all brought into the ascending and decending vena cava; it will not, of course, be supposed that the first veins arise from the extremities of the system, but those nearest the heart are formed first, and others enter these; now it must be seen that as small streams enter a large one and swell its dimensions, so all these small veins unite to form the vena cavas. This inner tunic

of the veins is necessarily formed in a manner similar to that of the arteries; the muscular coat of these organs, not being under the influence of the action of the heart, but influenced by its vacuum and pressure on the outside, is not formed elastic; the areolas or outer coat of the veins is described as very much thicker than the same coat in the arteries, and it is here, no doubt, that the nerves ramify, which assist in the pressure on the veins. It will, of course, be seen that the arteries arise from the heart, the capillaries from the arteries, and the veins from the capillaries on the principles of stems of vegetables.

14. The lymphatics commence their formation at the points where they enter the veins, on the principle of absorbnets in roots, and others arise from these in the same way; the difference in the appearance of veins and lymphatics is due to their different modes of formation. The valves of all blood vessels are due to the direction of the current for their structure.

15. In the formation of bone, cartilage, ligament and tendon, the cells form first on the same principle as other cells, and they are afterwards filled with the deposits required to perfect the organ; this may be known by observing their appearance when the earthy material has been removed. The formation of the internal organs of the body will be shown in the third part of the book.

16. The epithelium which fills the inside of some and covers the outside of others, of the follicles of the mucus membranes, that line so many organs, I judge, to form in the following manner: first, the follicles form the same as any other cells, and then from the inside or outside of these cells others arise, which are the

epithelium, and as fast as they form their inner or outer ends, whichever it may be, are opened by friction; these cell layers of the epithelium continue to form on their inside, while the lymphatics remove the outside with corresponding rapidity; the epithelium is of course formed by the influence of the heat, which is ever present in these organs. Now I would ask what influence formed the blood vessels of the pulmonic and those of the systemic circulations of the lungs, if it was not evaporation through the trachea? and what influence continues to form the epithelium of the cells, if it is not combustion in the tubes leading to them? The cell formation of the nervous system I think proper to treat under that head, in the third part of the book.

17. The conditions to effect perfect Cell Formation in the Animal Kingdom, consist in a supply of nutrition and a fluid, in which it can be sent where it is needed, and air and heat to form vacuums; and if all of these wants are supplied, then the blood cannot be sent, if the engine is not in working order. What would we think of the judgment of one who was attempting to raise water through a pump which was full of holes?

18. If all these conditions are requisite to restore wear, to cure disease, to heal injuries, and cannot be perfectly effected without them, how important that we provide for their existence; unless we are indifferent in regard to the preservation of this house, which is the greatest talent ever committed to our care, and one which embodies all of the rest.

19. We have seen that without a due degree of heat on the surface of the body, that freezing commences

here first; it may be well for us to enquire into the cause of these effects.

20. I have heard the statement made that our skin parts with its heat so rapidly in a cold atmosphere that freezing takes place, but I judge that parting with heat rapidly, so long as it continued to generate in the air tubes, or in the capillaries of the skin, would not produce freezing or congealing the fluids of the system; but parting with the heat of the surface first takes place, contracting the tubes until they will not admit air sufficient to sustain combustion; consequently, the vacuums are at first but imperfectly formed, and finally not formed at all, because there is no air admitted, thus the power to perpetuate circulation is cut off; the circulation becoming slower and slower, drowsiness comes over the whole system, nerves being included, until the spirit, disgusted with such a residence, leaves for its regions where it can exercise its natural powers, which are action.

21. Now if these are the results of a great exposure to cold, would not any degree of cold, from which we suffered pain, produce deleterious effects, causing circulation to lag? but circulation is quickened by cold so long as the cold is not sufficient to close the pores and exclude the air, and the reverse state will always be known by suffering pain.

22. It appears then that when we are exposed to cold, it is of great importance to be sufficiently protected by clothing to feel comfortable; hence, also we see the necessity of keeping the pores of the skin free from obstructions of any kind that air may always be admitted for combustion.

23. I have frequently observed the case of an indi-

vidual, apparently in the best of health when leaving home, who, after taking a long ride in a very cold day, returns home a changed person, the skin is dark because the blood is in partially congested state and moving sluggishly through the system, retaining much refuse material which has not been eliminated through the proper channels in consequence of defective circulation, produced by the pores remaining so closed that air cannot be admitted for combustion, and consequently vacuums are not formed, or very imperfectly, if at all; meantime the whole system, endeavoring to sustain its burden of disorganized matter, finally sends it to the weaker parts of the body; these being unable to throw it off, it here creates still greater destruction than that which existed before in the cell structure; the system continually suffering chills for the want of circulation, which we have already seen to be the great heat producing cause of the system; injuries and deposits, under these circumstances, take place, which months cannot efface, and with the treatment it will in all probability receive, may never be effaced.

24. I have often thought that if persons who are so judicious in the management of their interest in other respects could know their danger here, they would not neglect a matter of such vital importance as an early attention to a bad cold, which is soon set right if taken in season, and if not, may form deposits that will never be removed.

25. The reason why the disorganized matter attacks the weaker parts of the system when circulation is obstructed, is because the cells are defective in those parts, and the mischief can crowd through and find

vent, otherwise it would make inroads in some other part.

26. There is little danger, under ordinary circumstances, that the system will not be supplied with moisture; but there is great danger that the fluids taken into the system may contain impurities or stimulating properties that may prove deleterious to the health.

27. Impurities, by loading the blood with improper elements, obstructs circulation and thus makes deposits which tend to weaken the cell structure, and if continued for a sufficient length of time will produce fever and all its train of congestive difficulties.

28. Inebriating drinks, by their stimulating power, prevent perfect chemical action in cell formation; they also, by stimulating, weaken those which are already formed, thus gradually rotting, as it were, the whole cell structure, and undermining the house in which we live.

29. Any stimulating drinks or drugs that carry us on to perform more than we have strength to do without its influence, though slower in its work of destruction, is equally sure. The reason why stimulating drinks, that enable a person to act on artificial strength, produces the effect of making them feel stout, is because they either contract or swell the organs for the time being, thus drawing together rents in cells, and giving to the person power to destroy what is left, of which fact they are not aware until the mischief is accomplished.

30. As before intimated, it is impossible to produce perfect action through a broken cell structure; and

besides defective circulation, which can at best but partially repair the cells, another evil ensues which is more lasting in its effects, and greatly complicates that of imperfect cell formation.

31. When the blood is stimulated or loaded with impurities, or from any other cause, fails to perform its duty in mending the broken defective walls, the blood in the capillaries moving slowly in distended vessels crowds through the weak and defective portions of the cell walls, depositing disorganized and other mischievous matter, which should be carried through the organs and changed to hydrocarbons or thrown off.

32. The deposits between the cell walls produce evils which have received so many different names, according to the different characters they have assumed, that I should not care to receive a commission to give the names of all, but I will mention a few just to give a key, as dropsy, rheumatism, swellings, etc. Unless these deposits are removed by the lymphatic absorbants, health cannot be restored.

33. When a person is placed in an atmosphere of carbonic acid, death is the instantaneous result, for two reasons; the combustion in the lungs and in the air tubes of the skin are both suspended in consequence of the extinguishing character of the gas mentioned.

34. When the air is cut off from the lungs by the introduction of some foreign substance, death occurs nearly as soon, because when the action of the lungs ceases the blood cannot be brought even through the short circulations.

35. The want of air in the lungs cuts off the power to send the blood from them for two reasons; first,

the supply of air always existing in the lungs, or rather their tubes, keeps a constant vacuum in the lobules or clusters of cells, and when the air becomes so depreciated by the carbonic acid which is constantly forming that it has not power to produce vacuums sufficiently perfect to allow the heart to contract, the blood is not removed from the capillaries through the pulmonary vein; second, the depreciated air continues to destroy slowly the hydrocarbons already in the lobules, and this small amount of vacuum tends to hold the blood in the capillaries by producing pressure from the tissues towards the lobules, which could not exist were these cells filled with hydrocarbons, and when the air in the tubes is entirely exhausted the gas enters the lobules and completes the work of suffocation; when action in any part of the system is stopped a sensation is experienced which we call suffocation, it is of the same character as that felt on the skin when the air is excluded; sensations of the same kind are experienced in any part of the system where congestion exists.

36. If an entire want of air produces immediate death, any want of it would produce its corresponding evils, by checking circulation, by retaining mischievous matter that should be thrown off, and making deposits where they should not be made.

37. Again we must have nutrition; the consequences of undertaking to build a house without proper building materials would be to raise an imperfect structure. These building materials in the Animal Kingdom consist mainly of the albuminous group, which are issomeric as well as the non-nitrogenous.

38. The consequences of taking too much food

would be equally injurious; when an amount of food disproportionate to the calls of the system is taken, if the stomach can handle it, the blood thickens and increases in quantity, crowding the large vessels, and injuring the capillaries by depositing elements which are uncalled for by the wants of the system; these difficulties end in fever and its kindred train.

39. Any exhaustion of system, by over exercise of mind or body; or by depletion tends, by reducing nutritious elements, to produce defective cell formation.

40. The causes, which have been enumerated, form the most obvious of evils, that tend to produce imperfect cell structure; but a cause exists, out of sight, to which all of these, when compared with it, become as nothing; not, but any of these would be sufficient to produce death, and often do, but these are met, and combated, while the one great cause, which embodies nearly all the rest, is left to work its destruction in secret and unmolested.

PART III.

THE NERVOUS SYSTEM.

CHAPTER 1.

Cohesive, Chemical and Electrical Forces, Illustrated.

1. Soon after I discovered the principle of capillary force, my mind was led to investigate those, called Cohesive, Chemical and Electrical Attraction, and I almost immediately comprehended the laws connected with them; but I did not, at that time, intend to introduce them into this work, because I had not then seen the call for them in this place.

2. To show the principles connected with Cohesive Force, that is the power, which holds together atoms composing the same element, we will, first, investigate the cause of gravity being the greatest at the surface of the earth, or at the surface of any body whatever; and second, we will investigate the cause of gravity increasing as the quantity of matter increases.

3. I shall say nothing on the different views of philosophers in regard to the cause of gravity, that is whether it is produced by attraction or pressure, but shall take the principles which have already been demonstrated by Sir Isaac Newton, and show their application in the phenomena in question.

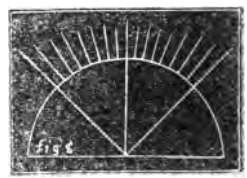
4. One of these principles is that gravity decreases as the square of the distance from the centre of the earth increases, and the other is that the power of

gravity increases directly as the quantity of matter increases; the simple reason why gravity decreases as the square of the distance from the centre of the earth increases, is because the surfaces of spheres are in proportion to the squares of their radii, that is, the square of the radius of a sphere multiplied by 12.5664 =the surface, now, as 12.5664 is a constant, it follows that the surfaces of spheres are in proportion to the squares of the distances from their centre or the squares of their radii; hence, we see that all of the gravitating power that exists or that would exist on the surface of a sphere any distance from and surrounding the surface of the earth, would all be brought into the surface of the ball when it reached that surface; this is a principle well understood by mathematicians and philosophers, and it is identical with that of light decreasing as the square of the distance increases: the foregoing views show why gravity is greater at the surface of the earth, or any other ball, than it is at any distance above it, and the reason why gravity decreases as we go below the surface of any ball, is because a body, one foot below the surface, is acted upon by the matter above it as well as that below it: hence gravity is always the greatest at the surface of any body whatever.

5. Having shown why gravity is the greatest at the surface of the earth, we will proceed; secondly, to show why gravity increases directly as the quantity of matter increases; to illustrate this principle we will take two spheres of different diameters, but of the same material, and show the difference in the amount of gravity existing on their surfaces, and consequently show the force with which they are held together.

First we will take the earth, and by the rule for finding the volume of a sphere we will multiply the cube of its radius by 4.1888—64,000,000,000 x 4.1888, which gives for the volume of the earth 268,083,200,000 cubic miles; second, we will take a sphere one mile in diameter, of the same material with that of the earth, and we will multiply the cube of its radius by 4.1888—½ x ½ x ½—⅛ x 4.1888, which gives for the volume of the mile sphere .5236 cubic miles, and dividing the volume of the earth by the volume of the small sphere—268,083,200,000 divided by .5236—512,000,000,000, this shows that the volume of the small sphere equals 1–512,000,000,000 of that of the earth; and now we will examine the surfaces of these two spheres by the rule for finding the surface of a sphere, we will multiply the square of the earth's radius by 12.5664—16,000,000 x 12.5664, which gives for the surface of the earth 201,062,400 square miles; and the radius of the mile sphere when squared—¼ mile, and ¼ x 12.5664—3.1416 square miles for the surface of the mile sphere, now dividing the surface of the earth by the surface of the mile sphere—201,062,400 divided by 3,1416—64,000,000,000, hence we find that we have 1–64,000,000 of the surface powers of gravity on the small sphere that we have on the earth; now dividing 1–64,000,000 by 1–512,000,000,000, or what is equivalent; dividing 512,000,000,000, by 64,000,000—512,000,000,000 divided by 64,000,000—8.000, thus we find that the small sphere is held together with 8.000 times the force, with which the same volume of matter in the earth is held; it is to be remembered that the elements of the two spheres are the same; this is one of the causes of matter attracting in proportion to its quantity. It will be found that if we take a sphere which is but 1-8000 of one mile in diam-

eter, and that would be less than one foot, we shall see that it is held together, that is the same volume of matter is held with 8000 times the force with which the same volume in the mile sphere is held; thus we are enabled to see by multiplying 8000 x 8000=64,000,000 that the smallest ball is held together with 64,000,000 times the force with which the same volume of matter is held together in our globe, and we see how this power would be increased by taking a ball, which is 1-8000 of the diameter of the last mentioned one, when this would be held with 512,000,000,000 times the force with which the same volume of matter in the earth would be held. Now it must not be forgotten that this is only one of the conditions of gravitating forces, the others being the density or amount of matter.



6. Now it may be asked why, if these things are so, does not the small sphere draw the Earth towards it instead of being drawn to the Earth itself; the reasons are obvious as will be seen by drawing a circle 1-40 of an inch in diameter, and forming on its surface 8 radii; by observing this diagram we can see that not more than one line of gravitating force which touches the surface where this power is greatest can act on one body at the same time; this is in consequence of the few lines that can be drawn on a small circle and

their great divergence (see fig. 7.). The second reason can be seen by drawing a circle one inch in diameter, and forming the radii on a quarter of the surface of this circle; by observing this diagram it can be seen that many lines of gravitating force can act on the same body at the same time when placed at a distance from the circle (see fig. 8.); and the larger the surface the more force it can exert at a distance, that is the materials being the same, of course all lines not touching the Earth or any other body would have less force, because they would strike obliquely and destroy each other. It becomes obvious, from the foregoing illustration, that gravitating lines toward a plane surface would act more powerful at a distance than from any other, but they would not be accelerated as those of a sphere, and beside, this action would tend to destroy the plane, whereas in the sphere it tends to preserve it; now we are enabled to see why a small body cannot exert an influence at a distance although held together with far greater force in proportion to its volume than a large sphere. This explanation of the gravitating forces on the surface of spheres shows why the Sun is able to hold the planets and order their motions; also, this very same principle has caused light and heat to bless the universe of God, and the power which holds all bodies to the Earth that are near it is the same; and further it is the force acting towards the Sun, and that acting towards the Earth in connection on our atmosphere, that produces the ever dancing motions of light; this is because their respective conditions are constantly changing by the motion of the Earth on its axis and in its orbit; and it is the same Gravitating or Cohesive force that gives the motions of light around every object and enables us to

see them; and these principles account, also, for the densities of the planets; for instance, Mercury, which is but 3,000 miles in diameter, has a specific gravity of 6⅓; Venus, whose diameter is 7,500, has a specific gravity of 5⅞; the Earth is 7.912 miles in diameter and its density is 5⅝; Mars is 4.300 miles is diameter, and its density is expressed by 4; Jubiter is 85.000 miles in diameter and its density is 1⅜; Saturn is 70,000 miles in diameter and its density is represented by ¾; Neptune is 37.000 miles in diameter, and 9-10 represents its gravity or density, they being the same; Uranus is 33.000 miles in diameter and 1 equals its density; nor could these planets of light density exist in the powerful gravitating force which surrounds the minor planets; although some discrepances exist in the densities which have been given, yet they correspond sufficiently to show the principle which has been illustrated.

7. Having finished our explanation of the first cause that influences gravitating forces in acting in proportion to the quantity of matter, we will enter upon a second.

8. To illustrate this second cause of gravity, we will take two globes of equal size, and we will suppose them to be composed of different elements, so that one is solid and the other is porous, and that the solid ball weighs one pound, and the porous one weighs one-half pound, and consequently occupies but one-half the volume of the ball, the other half being vacant; now we will bring the gravitating force on to these two spheres; it becomes evident that just one-half of these lines of gravitating force could touch the surface of the light ball, the rest would pass through and con-

necting with those of the opposite side would act precisely as if no matter existed there. Hence we see why the powers of gravity, under the two influences, which have been illustrated, acts in proportion to the quantity of matter.

9. Now, it cannot but be understood that these two conditions of matter, that is, their density and size must be causes ever exerting their influences around every particle or collection of particles of matter, however great or small they may be; it might, perhaps, at the first moment, be supposed that these two causes would be sufficient to account for all the modifications and varieties of force with which we meet in cohesion and yet it is not; neither of these forces can render the slightest ground for the existence of the accidental properties of matter; as, maleability ductility, brittleness, etc., here another cause *must* be sought, because bodies of the greatest weight are not in all cases held with the most tenacity.

10. It has already been seen that gravitating forces act in direct lines to surfaces; as the weight of the atmosphere is derived from gravitating or electrical forces, and as atmospheric pressure acts with equal force on all surfaces of the same depth with which it comes in contact, that is, water receives its power from air as air does from electricity, it follows that all gravitating forces act or are influenced by the shape of the particles or collections of particles of matter, upon which they act, whatever may be their size or density. The different shapes or forms of particle or collections of matter, must, therefore, influence the power with which they are held, and enabling them to slide more or less easily upon each

other, give to them their accidental properties. For example, the particles or atoms, which from their shape will make the closest pack, will give the greatest density; those which would touch only at the smallest points, the greatest porosity; those which are so fixed as not to allow motion without separation the greatest brittleness; those which will slide on each-other by tension and be brought back by their currents when the tension is removed, will give the greatest elasticity; those which are long so that they may be drawn without breaking, will give the most ductility; those which are flat will give the greatest maleability; those whose currents will make the most perfect union, will give the greatest tenacity, etc. These three causes existing in the conditions in which we find matter placed, accounts satisfactorily for all the phenomena with which we meet in cohesive forces; but it must be observed that the last cause, that is, the shape or form of the collections of matter, influences the action of gravitating forces, in either collecting them into spheres or entirely separating them; this influence is the real motive power which causes the main mutations of matter under all conditions.

11. Now, it does not appear to me that any one who has followed this course of reasoning, can, possibly question the fact that the three conditions of matter, illustrated, that is size, form and density, must be the ground of all chemical action, that is the form of the atoms or collections, with the other conditions mentioned, enables some particles to unite more readily and to be held together with greater force than others. Here it is proper to observe that cohesive and chemical forces *must* first exist, in order that gravitating or

large collections may be brought together. And it is proper to observe, further, that all of the conditions of matter, which have been mentioned, depend for their force upon positive and negative conditions of electricity.

12. To illustrate what is called Electrical Attraction, we shall be under the necessity of explaining the true cause of all gravitating forces:—we have seen in the illustration on Cohesive Force that gravitating power acts directly as the quantity of matter; and that where no matter exists the lines of gravity meet and act precisely as they would were no matter in the universe; now there must be a cause why electricity, when intercepted by matter, gives gravitating force; and we will observe, first, that the reason, why electricity surrounds every body, great or small, is because wherever matter exists, there exists a negative state of electricity; second, when this force is partially intercepted by matter, this fluid accumulates and forms a positive condition relative to its surroundings, and thus, generates a current or currents in some direction from this accumulation or positive condition, and this current or currents being established, gives the general Gravitating, Cohesive or Electrical Force, on the same principle that air is thrown into the track left by lightning, and produces, when it meets, the sound which we call thunder; this same principle is seen in the gravitating influences, which surround the earth; the electricity drawn by the negative state of the matter, of which the earth is composed is partially intercepted by the crust of the globe and its accumulation forms a positive condition, and establishes currents in a horizontal direction, which show themselves at the poles, and at the mouths of volcanoes, and these currents are

the outlets or drains for the whole electrical atmosphere of our globe, and constantly bring this electrical atmosphere, and the air with it towards the ball effecting gravitation: because all gravitating influences act in lines perpendicular to the direction of currents. The reason, I conclude, why currents are turned towards the poles, is, that the greater gravitating force, which exists at the Equator in consequence of the greater amount of matter there, and the action of the Sun, produce a negative condition at the poles; and the current is turned mainly towards the north in consequence of the greater amount of matter, which exists there; this influence is, I conclude, the cause of the form of the continents; and this current, emitted from the north pole, I judge, to be the cause of the earth's being farther from the sun in summer than it is in winter, and produces the ellipticity of the orbit of the earth, and, of course, like causes produce the ellipticity of other orbits, that is, these currents prevent the near approach of the globe to the sun; and the reason why volcanoes break out in the regions where we find them, must be due to the greater amount of matter, which exists in those vicinities. Thus the electrical atmosphere of our globe preserves its equilibrium, by turning these currents after they leave the surface, to perform their part in sustaining the gravitating force of the ball.

13. As every cylindrical body is always acted upon by gravitating lines from its convex surface to a line drawn through its center, there is always a current passing through the center of every body in this form, which is a conductor; and now, I hope we are prepared to understand, why this current becomes sensible when

an additional amount of electricity is thrown upon it by artificial means.

14. To obtain a little further insight, in regard to the action of eléctro-magnets, or electrical attraction, we will suppose ourselves in possession of two bar magnets; now calling the ends where the currents enter them, the positive poles, and the ends where the currents leave them, the negative ones, if we bring the negative pole of one to the positive of the other, the current from the negative pole will enter or be drawn in with that, which is entering the positive and they will be said to attract each other; and if we bring the positive pole of one to the negative of the other, the current, which is leaving the negative will be drawn in with the positive, and the same effect, as before, will be produced; but if we bring the two negatives together, the currents, which are leaving both will interfere and repel each other, and if we bring the positives together, they will be repelled by the interference of the currents which are striving to enter both.

15. It may be supposed, perhaps, that as we have shown Cohesive force to be capable of acting, only at the surface or a very short distance from it, and as it is is known that Electrical and magnetic forces act at some little distance from the surfaces under their influence, it may be supposed, I say, that Cohesive and Electrical forces are not of the same character: but we may remember that in cohesive force, the lines of gravitating influence converge so that few can act on the same body; and that in the phenomenon of the armature being drawn to its magnet, the lines of force act parallel, so that many can affect the same object; but both must be under the influence of the amount of

matter, and the condition of the action of the gravitating forces.

16. Now we have seen that gravitating and cohesive forces owe their influence to a capacity for establishing electrical currents; and that capillary force is due, indirectly, to the gravitating force of the earth in establishing currents of electricity; and that electrical force is a current that has been established by artificial means, that is what we call electrical attraction is such a current, and it seems not necessary to observe that electro-magnetism is the same action that is produced by currents of electricity.

17. The idea has been suggested by some authors that chemical affinity is due to positive and negative conditions of the atoms of matter, they supposing some atoms to be positive and others negative; that chemical affinity is due to positive and negative conditions of matter, I think no reasonable doubt can be entertained; and I am equally certain that both of these conditions must exist on the same atom, because there is no possibility of a particle of matter existing without both; and, of course, they unite or are drawn together by the union of their negative poles with the positive of others. The size of atoms explains the impossibility of chemical affinity, proper, exerting an influence beyond their own dimensions.

18. Now a question naturally arises why, if electricity has no weight, will a current of it sent into an object, induce cohesive or electrical attraction, as it is called? These both being induced by currents of electricity under different circumstances are of the same character as we have already seen: the reason why electricity has no weight is because it is a universal

substance pervading every part of infinite space, and sustains itself, giving weight to other bodies at its will; there would be as much reason in supposing that a quantity of coarse materials scattered through the air, would give weight to it, as to suppose that any influence could be brought that would give weight to electricity, because it is finer than any other element. That electricity does pervade all spaces, is shown by its power of transmitting light between the heavenly bodies, where no other element exists; and this light is the real gravitating lines of electricity that exist towards these bodies. To show why electricity, when sent into an object or conductor, will give cohesive or as it is commonly called, electrical attraction, it is necessary to view this element under two different faces, both of which are constantly presented to us; the first of these faces is where electricity gives weight to or drives other bodies before it; as the pressure of the air or lightning rending a tree; the second is where electricity acting from another direction throws other elements into or towards the track left by electricity having passed; as the air thrown into or towards the track left by lightning producing thunder; now we must see that both of these faces are produced by the same cause, and that cause is the power of electricity to send other elements out of its way; in the first face it acts direct, and in the second indirect; that is, it acts on the air, and the air acts on the current; in the phehomena in question, that is electricity induced by artificial means, it acts under both these faces; in the first, when the current enters the conductor, and in the second, when electricity, acting from other directions and giving weight to the air, throws it toward the current and throws the armature with it.

19. After all that has been said and shown in relation to the action of electrical currents, I consider that a query may yet arise in the mind, as to whether these currents leave vacuums, and thus call gravitating power into action; in reply to this question, I remark, that a current of electricity sent through any substance or conductor, forms no vacuums of ordinary matter, unless that current is very dense; as, lightning; but every current of electricity, in passing from positive to negative poles, and it can pass in no other currents, is virtually running down hill, and it is followed by all its electrical atmosphere, and this force brings atmospheric pressure towards the current, because it is this element which gives this pressure. And now, I trust, we are no longer in the dark in relation to the action of electrical currents in producing gravitating, cohesive, capillary, chemical or electrical forces, as they all depend upon the same cause; and I will further remark that every particle of matter in every collection of material substances has its own current with its positive and negative poles, and that these cannot act contrary to each other and the collection remain together. Now, we have seen not only how gravitating forces act in proportion to the quantity of matter, but how each atom acts in swelling the current of these gravitating forces. The taste, the nutritive and the medicinal properties of different elements are of course, due to their electrical currents being different; and these currents are due to differences in size, quantity, and shape of the atoms.

20. We are now prepared to understand much of the phenomena of nature around us, to which our eyes have been hitherto closed; as gravitation causes the

fluids to enter the bodies and branches of vegetation, electricity must necessarily enter with the fluid, thus establishing currents, which cause powerful cohesive action, and thus sustain the body and branches in addition to that of the chemical combination of their structure; so the electrical currents, which circulate through the bodies of animals, establishes cohesive force on them, in addition to the chemical combination of their structure, and thus supports and sustains them in action and labor against gravitating influences.

21. Perhaps, some one is ready to ask, why God saw fit to create matter, thus establishing positive and negative conditions, and providing for himself a footstool, on which He can stand to carry forth the works of creation; with as much propriety, might we ask, why we seek the circulation of fluids in our bodies, and why we are not content to have congestion and inaction take place in our systems, or why we seek to live; surely we are created in the image of God; but the Bible gives the appropriate answer to this question; which is that "All things were created for the glory of God." The fluids in our systems could no more circulate without positive and negative conditions than God could carry forth the work of creation without them. Were I called upon to-day to give the original cause of the establishment of all gravitating forces, I should be forced to answer that I believe this cause to exist in the nature and the will of God.

CHAPTER II.

Anatomy of the Nervous System.

1. To be able to comprehend the great cause of imperfect Cell Formation, it becomes necessary to form some ideas of the Anatomy, Physiology and Hygiene of the Nervous System, and also, of the Spirit which inhabits this organ.

2. As the anatomy of the nervous system is so fully treated by practical anatomists, and as all of my own knowledge on the subject is derived from them, there is but one particular in regard to the structure of the nervous system, on which I deem it necessary to make observations; and that is, whether the motor nerves end among the capillaries, and the sensitive ones commence there, or whether they are connected at these points, that is the motors connected with the sensitives.

3. As anatomists have been able to make no discoveries on this subject, our reasoning here must be on the principle of the *reductio ad absurdum*, as it is in many other cases; did no connection exist between these nerves, the electric fluid sent out from the brain on the motor nerves, would not be directly returned to that organ, and in its movements would be continually tending to throw out and waste the semi-fluid substance, which occupies the inside of the filaments; nor am I able to see how the sensitive nerves themselves could be so prepared and filled with electric fluid as not to receive injury by the motions, into which they are forced by the action of contiguous muscles. The electrical current could be connected through other parts of the system, but it appears

highly probable that the connection is formed by the nerves.

CHAPTER III.

Physiology of the Nervous System.

1. As the nervous system is composed of materials, which we can handle, and which remain after death; and as this system is subject to action, it must also be subject to change, or to passing away and forming anew.

2. The manner in which the nervous system is renewed by blood carried to this organ, is apparent to all who investigate this subject; it is evident that the blood vessels or arteries which carry the blood to the brain and supply the tissues which cover the nerves, have been formed by and are still under the influence of the action of the brain and nerves; but the veins which take the blood back to the heart must be under the influence of that organ. This theory accounts also for nerves and blood vessels keeping so close company throughout the system generally.

3. As the capillaries of the nervous system, if we may be allowed to give them that name, accompany the capillaries of the circulatory system, it is but reasonable to suppose that the combustion, which takes place in the air tubes of the lungs and in those of the skin, makes demands, by the currents of electricity, which it establishes on them; it is easy to see how this is accomplished, because the motor nerves ramify on the tissues, which covers the muscles lying under the follicles, and are thus brought under the influence of

the air tubes, and, of course, a similar action takes place at the lungs; this action on the skin is the one that brings the electric fluid out on the motor nerves, for we must remember that electricity moves in currents where an opposite polarity exists; that is, the action in the tubes of the skin produces a negative state in the muscles that calls the electricity in the motor nerves to ramify on their tissues; this is on the same principle that the negative state of the fluid in the secretory organs calls the motor nerves to ramify on their tissues. As the sensitive nerves, in general, ramify on the skin they are in an electrical state opposite that part of the brain where they are sent; hence this organ makes a constant demand on them; thus these two influences, that is, the action on the skin and in the brain, keep up the circulation of the electric fluid through the nervous system, by means of which the condition of the body is constantly being registered on the brain by the sensitive nerves; we certainly know that the ordinary circulation of the electric fluid does not take place by volition, therefore another cause must be sought; what other can exist?

4. The medulla oblongata is, unquestionably, the electro magnetic centre of the nervous system considered as a whole, because the fluid from both the cerebrum and cerebellum, as well as that from the nerves of the rest of the body, is brought to this point to be distributed. It is obvious that mental operations take place in the cerebrum, because intellectual labor produces pain in this region, and always sends the blood in increased quantities at such times. It appears to me to be conclusive evidence that the cerebellum contains the reservoir from which all parts of the

body are supplied with the electric fluid to support organic life, because all of the nerves, upon which these organs depend, either commence there or are connected with this part of the brain.

CHAPTER IV.

Hygeine of the Nervous System.

1. It will readily be seen that the health of the nervous system must depend on the general health and condition of the rest of the body; and that as the general health depends much upon the action of the mind or spirit, so the health of the nervous system must, necessarily, depend much upon the same cause; the reason why nervous diseases are so difficult to cure is owing to the action of the electric fluid when the nerves are in a defective condition.

CHAPTER V.

Cell Formation of the Nervous System.

1. The filaments of the nerves must, necessarily commence their formation at the points where they enter the brain or the ganglia, and the sensitive nerves form on the principle of absorbents in roots, but the motor nerves form on the principle of the cells of stems of vegetables.

2. But it is the gray or cineritious portion of the nervous system, in which I feel a very peculiar interest, this appears to me to be an electro-magnetic center for the sensitive nerves, and a generating battery for the motor nerves; if we investigate its structure,

we find the most ingenious arrangements that could possibly be devised to promote the desired object; first, we see the separate cells, which serve as the cells of the battery, connected by fine nervous filaments, these stand in the place of wires in an artificial battery; second, we find the convolutions to be such as to multiply the power; and third, we notice that the head itself, and every separate ganglia takes a form, calculated to render its force a unit, and cause it to act together; now, if we remember what has been said in regard to Cohesive Force, and that the smaller the body the more powerfully it will be held by the gravitating or electrical force, which surrounds it, that is the elements being of the same kind, and also, remembering that the largest of these gray cells of the brain battery is less than 1-200 of an inch in diameter, these views, I say, cannot fail to give us a key to the electrical power exerted by the brain and the ganglia; these cells of the battery must, of course, form on the same principles as other cells are formed.

CHAPTER VI.

The Spirit that Influences the Nervous System.

1. The nervous system is not the entire residence of the spirit that inhabits a body, much less the spirit itself; but it is the organ by which the spirit performs its functions on the body.

2. In order to obtain an understanding of the spiritual existence that inhabits a body during life, it is necessary to have some conception of the character of God, and the agent which He uses in creation, because

our spirit is an emination from the spirit of God, by general consent, both of Christians and philosophers; therefore I hope I shall be pardoned for making a little digression in this direction.

3. It will not do to say that God is nothing, that would be equivalent to saying that there is no God; we cannot see the air, but we can feel it and see its effects in a thousand ways; we can not see God with the eye, but we continually see Him by mental vision, and also see His power in the same way; it would be as difficult for me to form an idea of a God of nothing as it would be to form one of gravitation acting between heavenly bodies without an intervening medium.

4. Nor will it do to say that God is destitute of life, of animation, of sensibility, or of motion; that would be to say that He has formed the creature from some element, which he did not possess Himself; it would be to say that when we, who are now living are gone, there will exist no power to create more; it would be to say that we are the authors of our own existence, and that when we die infinite power will be lost.

5. What a consistent theory the foregoing! Can any mixing of inanimate elements produce life and sensation? Yes; says one, certain elements, when brought together, produce chemical action: do they? I have yet to learn the first instance of chemical action without the influence of electricity, the agent of God.

6. When certain elements are brought together, electricity, caloric, or whatever name we may call this agent, sets to work to arrange them to suit itself, which it accomplishes; what! then does electricity move of its own accord? So far as we know it is capable of moving independent of any power but that of

God. Who ordered it to create and hold together the heavenly bodies? Who has helped it to take charge of every atom or collection of matter by cohesive force? Who has taught it to create beings in the image of God? Most certainly we have done *none* of these things. "Where were we when the heavens were formed, and the foundations of the earth were laid?"

7. "God is a spirit" that creates and governs the world, says the Christian. The God of nature created, and *He* governs this world, says a certain class of philosophers; the word nature signifies some innate inclination or tendency; how much difference exists between the opinions of Christians and philosophers on this point?

8. "God," says the sacred writer, "is the same yesterday, to-day, and forever," "He changes not," "He sendeth rain on the just and on the unjust;" God governs the world by unchangeable laws, says the philosopher; how much difference exists between these opinions?

9. "There is no respect of persons with God, but he that worketh righteousness is accepted, and he that worketh evil is rejected," says the Christian; the laws of nature are universal, and whoever violates them, will suffer the penalty, and whoever lives in accordance with them, will receive the blessings which they bring, says the philosopher; wherein exists the difference in these views?

10. It is incompatible with the justice of God to allow the wicked to be happy, says the Christian; it is contrary to the laws of nature, says the philosopher,

that the violator of these laws, should not meet the evils, which they never fail to bring.

11. "God will take the talent from him that does not improve it, and cast him into outer darkness, there shall be weeping and gnashing of teeth," says the Christian; the spirit that the God of Nature gave to man, he will take, and the violator of the laws of nature, he will destroy, says the philosopher; let him who craves to sit in judgment on the difference between these opinions, ascend the seat; I do not; these observations are not intended for those, who have no definite, established views.

12. But perhaps, we had better return, and examine some of the known laws of this agent, which we call caloric, electricity, imponderable element, and of which God makes use, in His creation and government of the world.

13. So far as we know this element or agent is never found in a quiescent state. As every substance is surrounded by its electrical atmosphere, and this atmosphere, influenced by its surrounding media and objects, is always in motion; it follows that when it surrounds and fills a body, which will not allow it to move freely in all directions, but conducts it in some particular directions, that it must form a dense layer, which is continually in radiating motion, from the center in every direction in case of a sphere, and from a line drawn longitudinally through the center of a cylinder, in every direction towards its convex surface; it also follows, that the more dense the substance, the more dense is the electrical atmosphere or layer of this element, and, consequently, the more powerful currents it can establish; it will, of course, be remembered

that all matter even to the smallest atom must have its current, or currents, and that these currents have their positive and negative poles, and that the current must always move towards the negative; the ease with which this current can be changed in some substances is seen when we establish a positive condition at either end of the same wire by the influence of a battery.

14. If we place a small tube on the outside of a knitting-needle, the moment we shove on the needle sufficient to move it, that moment the other end moves; now suppose a dense layer of electricity to fill the interstices of a wire, and an impression to be made on one end of it by a current from a battery, that instant it would be perceived at the other.

15. Electricity being the only substance, by which an influence can be conveyed in so rapid a manner, it follows, that as no perceptible time elapses between a volition and the motion of the muscle, that the messages, from the brain must be sent in this manner. But how are they sent? and through what organs?

16. We will first examine the manner in which these messages are sent. If God has a way of doing all that He does, how does He manage this affair?

17. When a person has a solid foundation, on which to stand, he can push against another object with all the strength of which he is possessed; but if the foundation will give, he will push himself back as fast as he pushes other things forward, because, "Action and reaction are equal."

18. It has already been seen that electricity, in order to establish currents, requires a foundation of matter, on which it can accumulate a sufficient quantity of this element to produce a positive condition; now if

we can find a solid foundation for this ever active agent, electricity, we may learn how he performs his functions on the body; and we can notice that the shape of the inner surface of the skull as regards its concavity, together with the falx and tentorium are peculiarly calculated for this purpose.

19. It has already been seen that each little cell of the cineritious portion of the brain constitutes, by virtue of its gravitating or cohesive force, a power immensely greater than that of the earth in proportion to its size, and that this power is further augmented by the cohesive force on each separate battery or convolution, and it may be seen that this collection of batteries is still further multiplied by the gravitating or cohesive force, which surrounds the skull itself, which gives this solid foundation; now with the whole brain resting against the *dura mater* of the skull; and the difference existing between the polarity of the cineritious portions and the nerves; and with these powerful batteries at its command—taking into consideration these things, can we fail to discern how it is able to send its mandates, and to continue its action in muscular contractions by the volition of the mind? The crossing of the nerves in the cerebrum and in the medulla-oblongata, gives evidence that the mind sought a footing in a direct line with its motions, instead of an oblique one, where it could not possibly have the power required.

20. Before entering upon the description of the organs or nerves, through which the messages are sent, I think proper to make a few more observations illustrative of electrical currents and their influence:—had we a tub of water, and should we make an orifice

through the bottom, by which the water could run out, this current would not only settle the water directly above the orifice, but it would settle equally the whole surface of the water until all was gone; now this is precisely what takes place in electrical atmospheres surrounding currents, whether those currents are through nerves or some other substance, that is the whole electrical atmosphere surrounding a current through a filament of a nerve would be brought towards the current and with it atmospheric pressure, because this element is what gives atmospheric pressure.

21. We will now examine the organs, through which the mandates are sent both from and to the brain; these may, with all propriety, be classed under two general heads, without interfering with the divisions already made by authors; these classes are the voluntary and the involuntary nervous systems; the voluntary being those under the control of the will, and the involuntary those under the innate or unrevealed will of the mind.

22. It becomes evident that the electric fluid in passing a wire is sent through the entire interstices of the wire, because the resistence of the wires to this current is in the proportion to the inverse ratio of the square of the diameter, whereas, was it sent on the outside only it would be in the inverse ratio of the diameter, instead of its square.

23. It becomes evident, in case of the nerve, that the fluid is not sent on the outside of the nerve, because, were that the case, it could not be sent to each particular division of the nerve, but it would effect all parts alike through which it passed and be scattered and

spent before it arrived at its destination; therefore, it must be sent on the entire body of the nerve, that is, to move an arm the fluid must be sent on the entire substance of the motor nerve of the arm, and if sent to a finger, must be sent through that part of the nerve of the arm which leads to the finger.

24. As the sensitive nerves return the current, which is sent out on the motor nerves, and thus complete the circuit, it is easy to see how they are enabled to register on the brain what is taking place at their extremities.

25. The electric fluid, never being quiescent, must be in continual circulation through the nervous system; and as it cannot move contrary to the motion of the motor and sensitive nerves, it follows that it must move with them, thus forming a strong band of powerful tension and force throughout the system, making one feel braced and stout when the nerves are sound; but weak and trembling when they are in a condition to scatter this power.

26. Should any one doubt the influence of this power to give strength, let him reflect for a moment, on the case of an individual laboring under depression of spirits or want of mental stimulus, and on his case an hour after when influenced by a cheerful state of mind.

27. The plexuses, or crossing of the nerves, for ingenuity of arrangement, appear to be exceeded only by that of the brain itself; by noticing the plexuses, we can see that the acute angles of the crossings all lie in a longitudinal direction, and if we have obtained clear ideas in relation to the cohesive force which is brought on to every separate filament of these plex-

uses we shall be able to understand that as this cohesive force is brought on these filaments, it is greatly accelerated at the acute angles; this force, would, of course, shorten the plexuses longitudinally and bring up the contiguous muscles in that direction; thus, we are enabled to understand the use of the vertebral plexus in drawing back the shoulder, and that of the lumber and sacrel in drawing back the lower limbs: and all of the crossings of the nerves, must, of course, exert an influence in this way, and although the motion effected by this power is slight yet it is essential, and must have some force to produce it; also, I conclude that these crossings of the nerves give mechanical power, forming compound levers, especially on the tissues where they ramify, which facilitates the sending and giving direction to the fluid. This idea of mechanical power, may appear chimerical to some, as the nerves are soft bodies; the air is a soft body, and yet it serves as a conductor for a current of the electric fluid, which has power to rend the stoutest wood, and separate elements producing ignition; we must, of course know that when the filaments are filled with the current they become firm in consequence of the element within and cohesive force without.

28. But recollect that however nice the arrangement for action, if there is no motive power the machine stands still, to what would all of this fine arrangement of the nervous system amount, when deprived of its electrical or cohesive force, which first formed this nice adaptation of means to ends; could all the apparatus in the universe, without it, give life, or produce *motion* from *volition* or *sensation* from *impressions*?

29. But the question, which has baffled every mind

that has attempted to handle the subject, is, how does the fluid, sent out from the brain, act to produce muscular contractions? And it is not surprising that it should have done so, because, although the most capable intellects have endeavored to solve this mystery, yet they were not in possession of the data, on which the correct theory could be built, which is properly cohesive force; as gravitating, cohesive, chemical and capillary forces are all produced by electrical currents, it seems proper to designate each one by the more appropriate name belonging to the conditions of matter, under which these currents act.

30. Now as the motor nerves ramify on the tissues that envelop every muscle, and every separate muscle possesses its own sheath of tissue, which forms a complete net-work of plexus, it follows that when the current is sent through the net-work of motor nerves, the electrical atmosphere surrounding this tissue would be brought on to the tissue, and with it atmospheric pressure, because the gravitating and cohesive forces are what gives atmospheric pressure; it will be understood also that this cohesive force brings the muscles towards the tissue, so that as the tissue is shortened the muscles follow it up into a globular form, and this action is always in proportion to the force of the current; this principle of nervous influence is identical with that, which brings down an armature when a current is sent through the helix of its magnet, except that in the armature, the gravitating lines act parallel, whereas, on the tissue, they are converged. I would here make the remark that the reason why cohesive force shortens a muscle, is because all forces of this character tend to bring the bodies, on which they act into a

globular form, if the materials, of which they are composed will allow this action.

31. As soon as I made this discovery of the application of cohesive force to muscular contraction, I considered that the veins ought to be affected by this influence, and I immediately examined three authors in my possession to learn what discoveries anatomists had made on this subject, and I found that two out of the three stated that the outer coat of the veins consisting of areolar tissue, is much greater in quantity than that of the arteries; this gave much satisfaction to my mind, for although I supposed that the veins were supplied and prepared by nervous influence so as not to be injured by the pressure continually acting on the outside of them, yet I did not know that this pressure was increased by nervous action, which we cannot now fail to see. And I am now well persuaded that every flash of the electrical currents carries the blood in the nervous system a certain distance by a *vis a tergo*, probably from one valve to the next, that is, the venous blood through its whole course is removed from a valve back to the one ahead, and it appears to me that the regurgitating force at intervals of flashes has its influence in the formation of the valves; the veins near the heart being under greater influence of its vacuum have none.

32. The action that takes place in muscular contractions, is what is known under the name of magnetism induced by electricity; but that which takes place in the brain, by which the electrical fund is collected, is what is known under the name of electricity induced by magnetism. We cannot now, I think, fail to see clearly that the action in the nerves, has been the

cause of the arteries keeping them so close company, as they both form under the same influence, that is, vacuums produced by evaporation. But if the great sympathetic renders any assistance in bringing the blood through the arteries except the heart, the pressure must act to throw this force internally, because did it act externally it would throw the blood toward the heart, instead of from it, because the base of the arteries lie at the heart: that it does exert some influence in that direction, by plexuses on these organs, I am satisfied. But remember that all of this nervous power, wherever exerted is nothing more than a *vis a tergo.*

33. We will now examine the involuntary Nervous System, both as regards its structure and use; this by authors has received different names: as, sympathetic nervous system, and nervous system of organic life, both of which, are correct, and very appropriate.

34. According to authors that I have consulted, the ganglia of this system consists of batteries precisely corresponding with those of the brain, that is, each one has its cells connected in the same way, and is enclosed in a globular battery or ganglion, consequently, the power generated is of the same character; but it will be remembered that the brain has its power multiplied by the cells, by the convolutions and by the skull, while in the ganglia it is multiplied only by that and the cells, and not being under the influence of the will its force must be less, and its action dependent on impulses produced without volition, must be transitory: the reason why the heart acts with so much more power than other organs, which are under this system of nerves, is because it is so closely connected with

the vacuums at the lungs, and more remotely with the whole surface of the body, while organs, more distant, as stomach, second stomach, act slower and with less force. It must be seen, of course, that when the blood has just been sent from the heart, or food from the stomach that less pressure would exist on them, because there would be less matter or less cohesive force, but that the introduction of blood into the heart, or of food into the stomach would increase ordinary atmospheric pressure, and this pressure on the nerves sets the ganglia at work, and by reflex action sends a current through the tissues that covers the muscles and contraction is effected by the union of these two influences, that is ordinary atmospheric pressure and cohesive force produced by the current, sent from the ganglia. It is of course understood that both of these forces are, virtually, pressure.

35. Now, possibly, some may question, as the influence brought to bear by the nerves, is added to the ordinary pressure, whether this power would not be sufficient to promote circulation without vacuums; but remember that ordinary atmospheric pressure will not act without vacuums, and if it could it would be destructive to the parts on which it acted; let us, just for a moment, take into consideration the consequences, either, of having nothing but common atmospheric pressure on the heart with vacuums ahead, or having more than ordinary pressure on the heart, without the vacuums ahead; first if we have no more pressure on the heart than that which exists everywhere else in the system, and the vacuums at the lungs, and in the tubes of the skin, it is evident that the pressure near and outside the tubes, would close

down on them and destroy their influence over the heart, because that would be so much more distant and have no more pressure; second, if we have an extra amount of pressure on the heart, as we certainly have, and no vacuums ahead, then this extra pressure at one point without vacuums to give it direction, would tend to move in one way as much as in another, and would soon tear away the valves, and produce general destruction of the organ, because this force must be one that continues to act; it will not do to suppose that if the causes, which produced an organization were removed, the organization would continue: as well might we suppose that if the cohesive force of a stone were destroyed, it would still remain stone; thus, we see the necessity of both, extra power at the heart, and vacuums ahead of it; the difficulties that would exist without these two influences in connection, have presented their objections to me at every step, which I have taken in the theory of vacuums and pressure; and yet I could see no more than ordinary pressure on the heart possible, until I understood the true theory of nervous influence in muscular contractions. When I commenced this book, I supposed that ordinary atmospheric pressure and vacuums, without any increase of power from the nerves, caused the heart to contract, and that the action of the nerves only prepared the muscles for pressure without injury, that is, without being pressed so as to stop circulation in the systemic blood vessels of the heart.

36. We learn from anatomy that all of the different organs of body, that perform their functions independdent of the special volition of the mind; as the heart, stomach, liver, pancreas, etc., are supplied by this

nervous system, each having its own particular ganglia, and that branches of this system accompany the blood vessels throughout the entire body. The mesenteric, the hepatic, etc., plexuses, must, of course, exert an influence in circulation and in the functions of these organs.

37. It was mentioned in the fore part of this work that wherever a change of parts took place, electricity would always rush in, in order to establish itself on the new conditions; and all who have understood the illustrations on the establishment of electricity on bodies of matter having different quantities, size and form, will now be able to comprehend the reason of these movements of this all powerful element. We are now able I hope, to see the necessity of this system of nerves to accompany the blood vessels and supply the heat which is called for by the constant motion, which is taking place, much being thrown out at the surface and lost; and we have just seen the necessity of this system of nerves to place the tissues surrounding the muscles of every organ in a condition that cohesive force could act on them to produce contractions of the muscles; without this warming influence to prevent the fluids of the system from solidifying, and keep the parts warm and flexible, all parts would soon be destroyed by the friction of their motion, and driven by cohesive force to the great injury of its parts. that is if ordinary cohesive force could perform the work unassisted by the help of the nerves, this would be the result.

38. The necessity of the connection of the ganglia can be seen by the opportunity which is afforded to one organ which is in action to call the fluid from

those which are at rest and do not need it; and their necessity of connection with the brain is seen by the opportunity given for reinforcement of the fluid; hence we see the propriety of calling these nerves sympathetic; this shows why we can not use many organs successfully at the same time, because they cannot all be supplied with fluid; we see the propriety of calling this the nervous system of organic life, because no organ on which the condition of life depends could perform its functions without them; the reason why we do not become sensible of the reflex action which takes place through the sensitive and motor fibres of this system, is because the action is not returned to the brain by the sensitive nerves, but only to its ganglia.

39. The position which the brain occupies, peculiariy fits it to become the rule of the kingdom; it is from this source that the fliuid which follows up the bload is supplied, and it is from this source that the heat comes, which is used for ignition in combustion. Now a question arises, as to where the brain obtains it's supply to support the rest of the body; this fund must come from external sources, and is supplied in the following manner;—first, the external or gravitating force on the surface of the body, conveys this fluid through the sensitive nerves to the brain, because we must remember that electricity moves where negative conditions exist or where a current is already flowing; this shows why the heat is returned back through the sensitive nerves to the brain, when we are sufficiently clothed to prevent it from escaping; second, the globular form of the skull together with its density, causes a powerful cohesive force to act

continually on the external surface of this organ, and thus supplies it, also, from this arrangement; third, the food we receive, possesses its electrical or cohesive forces; fourth, the electricity produced by combustion in the lungs is constantly being returned to the brain on the pneumogastrics: thus, we see ourselves dependent upon God not only for our creation, but for our preservation, we cannot but see that, were He to withdraw His agency and take our spirits from us, our bodies must fall to atoms: how wonderful the movements of this spirit appear! When we reflect how rapidly this fluid is sent and withdrawn in continued action, where a muscle is first contracted and then relaxed in such close succession as is done in many kinds of labor, and with what nice precision are motions communicated to any particular muscle out of five hundred different ones.

40. I recollect somewhere, to have seen the statement made, that it could not be the electric fluid which is sent from the brain, because were that the case, the nerves and the brain would be warmer than the rest of the system, which is found not to be the case; this idea I think has obtained from not being acquainted with the character of this fluid; a man in a balloon will freeze while one at the surface of the earth under him will be too warm, this shows that the electrical fluid is intercepted and accumulates at the surface of the earth; it is the subtle power of this fluid in entering other bodies and separating elements, and the motions and feats which it performs when existing in powerful currents that give to us the sensation of heat and produce ignition of bodies; but there is no reason to suppose that electricity sent on to a semi-fluid, that will allow it to pass freely without interfer-

ence, could produce heat until it arrived at organs where its action is intercepted and thus accumulates.

41. It has been thought by some, that because the electric fluid, when thrown upon a nerve by artificial means, acts on all parts alike, that this proves it not to be electricity which acts on the body; but it is to be noticed that the fluid in the experiment, is thrown on the whole nerve without distinction of parts, which is not the case in the body.

42. The reason why a turtle, which has had its head removed, will on having a coal of fire placed on its back walk, is because the fluid is thrown on to all parts alike. It is in view of the powerful electrical currents, which continually circulate through our systems, that I have been led to deem it probable that carbonic acid might be decomposed in the body and enter other combinations, and with them be excreted from the system.

43. We will now make statement of a few facts, which the mind has not heretofore been prepared to receive: It has already been stated that the electric fund of the brain was supplied from external sources through the sensitive nerves; and we will now observe that these sensitive nerves are the real electric currents that serve as the drains for the electrical atmosphere surrounding our bodies, and give to them the cohesive force which sustains them against gravitating influences; and that the electric fluid taken in the great sympathetic and in the blood to internal organs; as heart, lungs, stomach, liver, &c., is returned to the brain through the pneumogastrics, and thus serves as the drain of the electrical atmosphere of these organs and gives them their cohesive force; but we may remem-

ber, that although this gives powerful cohesive force on the surface of the body and on the surface of the internal organs, yet this force decreases as we pass toward their centers, because all forces of this character are greatest at their surfaces. From the foregoing, four facts become evident;—first, that electric fluid is conveyed through the sensitive nerves to the brain from the whole surface of the body; second, that the action, which takes place in the perspiration tubes, is the influence that brings the blood from the left heart, and the electric fluid from the brain on the motor nerves to the muscles and thus build the limbs and walls of the body; third, that there are three influences which assist in bringing the blood to and building the stomach, second stomach, pancreas, spleen and liver; the first of which is action at the surface bringing the blood out on the aorta; second, the chemical action and elimination that takes place in the liver; third, the draft which the heart makes on the organs through the hepatic vein, and the fourth of these facts is that the blood is brought back from the whole of these circulations, freighted with the electricity of the chemical action, which has taken place in the whole system by the influence of the combustion, which takes place in the tubes of the lungs, and that this electrical fund is sent on the pneumogastrics to the brain; surely the spirit of the living creatures is in the wheels; thus we see that the electric fluid, which surrounds every organ or collection of matter; is the moving cause of the formation of sensitive. But it must not be supposed that the pneumogastrics or any other motoror sensitives nerves, posses any influence in moving the blood through the system, except as they give cohesive force

and act as *vis a tergo*. To illustrate this subject, we will take a bar magnet and place it on a paper and scatter around it iron filings, and we see that these iron filings do not arrange themselves in a line to follow up a current when sent through the magnet, but they arrange themselves perpendicular to the bar, thus showing that the current draws the electric fluid in a perpendicular line to its own motion, thus we see that pneumogastrics or any other sensitive nerves could exert their influences over the blood vessels only as they give cohesive force and bring external pressure on the veins or on other organs; could they exert an influence on the blood in the arteries or in the veins, it would produce general confusion in the circulation of the system. It may be seen, by taking into consideration the action of gravitating lines on the surface of the earth where the currents are turned in a horizontal direction, and run at every

int of the compass in consequence of being intercepted, and on magnets that the electric forces stand in lines perpendicular to the currents, and are not influenced by the direction in which the current is passing, unless it is in line with the current, as is seen in muscular contraction; and this influence must of course give a constant pressure on the blood vessels, or on any organs which are contiguous to these currents, and this gives a constant back force on the blood vessels; surely, "When the living creatures went the wheels went by them." And when we reflect that the currents of electricity, which enter our sensitive nerves, are connected with the sun, with the planets, and through them with other systems, through infinity of space, we cannot but realize that the rings *would* be so high as to be dreadful, did we not know that

these lines are held in the hand of our benificent and all powerful Father in Heaven. I have endeavored to say sufficient on electrical currents to give a key to the action of the spirit on the body, and enough on cell formation to give a key which would satisfy an investigating mind on this subject.

43. When this gravitating force or electricity acts on one body alone, it holds that body locked in unchangeable death; but as soon as the influence of another ball or body is brought into the vicinity, both seemed touched with a living coal of fire, and from chaos and death, at once spring life, beauty, and harmony; as in the influence of the sun on the planets, or their's on Him; but what is the condition of the poles where this influence is not felt? The reason for the statement just made, is that unless there are other bodies to call for opposite electrical forces, and thus keep a radiating action on their surfaces between them, the gravitating or electrical force on one body only, would rest on it after having established its currents, so as to meet no interference, and would produce no heat; thus, we are enabled to see why we are warned when we are under the influence of the sun, and why we have night when turned from him, and in the same way we are enabled to see how all of the planets can keep up a radiating motion on the surface of this immense body.

44. Now so long as we do positively know that all of the mutations of nature, as they are called, take place through the influence of the action of this agent of God, which we call electricity, that without it the waters, which float above us would descend to the earth and be congealed; and that men, animals and

vegetables, would need neither embalming nor petrifying to preserve them to all ages; and that at a second withdrawal of this power, these inactive bodies would fall to atoms; and that this self-same power created the boundless universe of splendid orbs, and that He still preserves them and orders their motions; knowing these things, I say, why should we stretch our imaginations to draw in some far-fetched idea of a finite form for God, and locate Him in some corner of the universe, with a sphere as limited as His form? Why will we thus cloud our intellects, depress our spirits, and destroy, not only our own confidence in God, and our hopes of everlasting life, but that of others, also, by placing these views before them? How *dare* we assert something in relation to God which is contrary to his own statement of Himself that, "God is a spirit and they that worship Him must worship Him in spirit and in truth."

CHAPTER VII.

Results of the Action of the Spirit.

1. As the Spirit organizes the body, and not the body the Spirit; when the affections are placed upon any person or thing, the nervous system takes form accordingly, and the electric fluid establishes itself upon this form; to illustrate, a young lady places her dependence upon her parents to provide for her personal wants,—she feels no anxiety, because she believes that they are both able and willing to care for her, her nervous system rests in comparative inaction on this subject, it takes a form corresponding with this inaction, the electrical atmosphere of the nervous system is es-

tablished upon this form;—she hears that her parents are killed by some casualty,—the electric fluid being established upon a principle that is no longer tenable must change, the nervous system must change, the action of the whole system must change; and this sudden arresting of the fluids through the system to produce change arrests the flow of blood, and consequently, stops both action of the heart and action of the brain, producing in some cases instantaneous death.

2. How important that the supreme affections of the heart should be given to an unchangeable object! Well may we, with the sacred writer exclaim, "Keep thy heart with all diligence for out of it are the issues of life."

3. All anxiety or undue excitement of mind, by irregular movements of the electric fluid, which is, as we all know, a most powerful agent, tends to tear down the cells, which form the house in which we live. Let us reason a little on this subject from analogy.

4. A child, in infancy, has no anxiety in regard to provision for its wants, and it has comparatively little in youth; in this state, we find it contented, and yet its powers and faculties are in a most active condition, —ever ready to learn something new.

5. No one can fail to see that this contented state of mind is favorable to development of physical, as well as mental powers, if he reflects on the influence of this condition of mind on himself; and accordingly, we find that children not only repair, perfectly, the wear of the system by friction, but they increase it in size, and further still, they actually rebuild, in the

most perfect manner, cell structures, which have been destroyed by disease or accident; because the mind remains in a condition to allow the Maker of this house to keep it in order, and repair it when injured, which He is ever ready to do unless prevented by us

6. There can be no mistake in these laws, no caprice in managing to favor certain individuals, surely, "There is no respect of persons with God," but "he that worketh righteousness is accepted by Him." It will readily be seen that these observations are not to be considered as applicable to those who are so situated as to receive external injuries or hindrances that are insurmountable, and that, in the present age of the world and state of society, is nearly every human being.

CHAPTER VIII.

The Great Cause of Imperfect Cell Formation.

1. I think that we are now prepared to understand something of the Great Cause of imperfect cell formation, which is continually sweeping multitudes to a premature grave.

2. As a child increases in years, the passive confidence it enjoys in regard to its wants, and which is the result of ignorance, gradually leaves it,—early it learns the lesson that prosperity in business is the fruit of indefatigable exertion;—it hurries its education, cuts it short, in order to enter the grand theatre of life; when there, it strives to equal, at least, all of its competitors, in whatever department of business it finds itself engaged; it becomes surrounded with more business than it can accomplish, care and anxiety take possession of the mind, and in place of that quiet

state formerly enjoyed, the electric fluid is rushing through the body in such disorder as to prevent the rebuilding of any parts which become disorganized;—health becomes precarious;—"the Heavens are becoming dark," "the heart is failing for looking on the evils, which are coming on the earth;" it is told that human life is short, that a premature death is the certain fate of all, that we must make the most of life, that we must work while the day lasts, which last is true, and if we work right we shall see the benefit, but if not, we might better remain inactive; if life is short, at best, should we so live as to make it shorter? Can we make the most of life by doing so many things wrong, and shortening it? That a premature death is the certain fate of all is not correct, notwithstanding, "All flesh is as grass," because, "the spirit of the Lord endureth forever." But we are admonished to be diligent in business; certainly, we should; but should we become reckless of the interests of the invaluable vineyard, of which we have received the stewardship? Should we become reckless in regard to the observance of those laws, on which we know health to depend? But I have sometimes thought that we are nearly as badly fixed as a man in a battle, who does not know that he is wounded until the battle is ended; it is certain that we are often entirely blind to the dangers, which we are incurring; and in the midst of all these evils, we are told to place our faith in God and all will be well, and so it will if we have implicit confidence, and let the people go that they may serve God, instead of keeping them so much taxed with care and business that they are incapable even of knowing their duty, much less of offering sacrifice to God; and God will do the best that He possibly can for us, under the circum

stances, if we do not, because, when we have entirely ruined our vineyard, and by our vices closed every avenue to the Tree of Life, so that the Spirit can no longer keep before our eyes the candle to enable us to discern our way; it will then, of course, be forced to turn its influence in a direction to destroy; and our vineyard will be taken from us and we shall be cast out.

3. Frightful are the evils of a zeal of God without knowledge, a faith without foundation, without works; surely the sacred writers have not over-coloured the dangers, have not given too many warnings, nor represented evils to come in an unjustifiable light.

4. But does there exist no difference between the person of faith and honest intentions, although ignorant, and the person who is willingly perverse in his ways? Most certainly, we are told in sacred writings, that "They that sin without the law shall also perish without the law, but they that sin against the law shall be judged by the law."

5. But I know of no promise, contained either in scripture, or in the known laws of God, to save its violators from the evils which it entails, so long as they continue those violations; but if they turn from evil ways, of course "They will receive according to their deeds, whether they be good or evil."

Language can indicate a fact no more clearly than the scriptures set forth the doctrine that the wicked without respect to the time or place where they are found, are miserable, and that they will continue to remain so, if they continue wicked. I suppose that any amount of evidence might be brought to show that sin in human beings, sometimes reaches a culmi-

nating point, from which there is no return; and the announcement concerning such, is that they shall be cast into utter darkness; that the talents which they possess shall be taken from them; that they shall be banished forever from the presence of the Lord, and from the glory of His power; that they shall be punished where the worm dieth not, and where the fire is not quenched; that they shall be held in shame and everlasting contempt; and that they shall finally be destroyed, root and branch.

6. But does it all come to this, at last; that there is no life beyond this? and no reward for the just and punishment for the unjust? Let us see how this appears to be under investigation; one individual cultivates a justifiable spirit, a spirit that wills to see the wisdom of God carried out in the universe, this is his greatest desire, this is the object of his great aim, he is tied to no idols, he harbors no unjust passions or affections, will this spirit of life, of which he is composed—this spirit that gives animation to the body, this spirit that is in unison with the will of God, die? Judge, are these the elements of mortality?

7. The spirit dies when the body dies, says a class who call themselves philosophers; does it? Then the spirit which God gave is more mortal than its agent electritity, for that always leaves the body after death; but I have never learned that it is an agent to change except in its position.

8. Another person cultivates the love of unjust pleasure, he wants all things to move in accordance with his particular desires, which are unjust and unreasonable; the nearer he approaches the termination of his career, the stronger is his desire to gratify vi-

cious propensities; and the less his taste for spiritual enjoyment; will his wishes forever die at death of the body, thus suffering eternal destruction? Or will they live forever to suffer everlasting disappointment of their unjust desires and propensities? If these evil propensities can exist after dissolution of the body, that is if they are immortal, I am unable to see their chance of felicity. That the sun will rise to-morrow morning is a fact, in the order of nature which is no more clear to the mental vision, than that if the civilization of the world continues to advance, all selfish desire, all unholy passions, all narrow minded views of good, if they have an existence at all, will be held subservient to the interests of general welfare, to pure and holy desires, to justice and equity, and to universal love for the whole family of our Father, who is in heaven.

9. To have evil propensities destroyed at death of the body, would be the very best thing that could possibly happen to the evil doers; but are we to understand that the spirit, which was given by God, is to die at death of the body? Will God destroy or punish forever a part of Himself? It is remarkable that on this subject, the testimony of the bible is in precise accordance with that which philosophers are endeavoring to establish, that is: "The body shall return to dust and the spirit to God who gave it." It is proper here to observe that it is not the spirit which we receive from God that sins, but it is man as a living soul created by the spirit of God, and in his image, who has violated all the laws, by which that spirit can confer on him felicity or even remain with him.

10. How are the dead raised? and with what body do they come? are questions that appear to have

troubled people in all ages of the world; "God giveth it a body as suiteth Himself," says the sacred writer; the God of nature will make all things according to certain laws which He has established, says the philosopher. If the God of nature is not the God who created the universe there must be two Gods, which I presume no one would be willing to acknowledge.

11. What opinion would we form of the condition of the mind of a fish; which on being told that it should be changed to a human being, were to commence its cogitations about losing its fins and its gills, neither of which it would need? This may appear to some to be a low brought comparison, but to me it appears precisely appropriate to the case.

12. It may be thought that I place a light estimate on the admonitions, "To work while the day lasts," "To be diligent in business;" no one could possibly make a greater mistake, because, I am so far from judging these admonitions as unsalutary, that I believe action, employment, a mind filled with intentions of carrying out plans of benevolence, and energetic in those plans to be an inseparable condition of physical health and spiritual enjoyment.

13. It is only the overworking, the inattention to the laws of health, that always obtain, when we become too much interested in the things of the world to maintain a calm state of mind, that I wish to call in question; in short, it is this unquiet, this discontented state of spiritual existence, that prevents the electric fluid from moving with regularity through the system, and giving to it the proper mental stimulus to maintain the nervous action of organic life. Accordingly, we always find physicians doing all in their

power to give to the patient a state of mind favorable to convalescence, and to keep from them everything that would tend to send electricity in disorder through the body, tearing dawn the cell walls, which are already in a defective condition.

15. The evils or this disaffected state of mind, are always two-fold; one is the rushing of the fluid through the system to points and in quantities not called for at the time; and the other is the indifference to the laws of moderation in exercise, that always accompanies this state of feeling; indeed, I think that this disorderly state of mind embodies, either directly or indirectly, the great mass of evils and suffering, to which flesh is heir. Hence we see the inestimable value of the admonitions, which are ever falling from the lips of the heralds of the cross of Christ; "To give our hearts to God."

16. The foregoing reasoning may not appear clear to all, but if we reflect just on what passes within our own observations, in relation to persons in apparently good health, who on some reversion of fortune or loss of friends, are brought to an untimely grave, or what is worse, lose their reason. If we reflect on these things, I say, we cannot fail to see that there is an *arm of mischief*, which is out of sight, and which slays its millions in secret and unmolested.

CHAPTER IX.

The Arm of Mischief.

1. A question arises as to where this Arm of Mischief, which produces such disorderly condition of our spirits is to be found? Where can we meet it? How

can we know it? How shall we defend ourselves against it.

2. Where is this enemy to be found? Can we be at a loss on this subject, when we have from such reliable authority, "That our adversary the devil goeth about like a roaring lion seeking whom he may devour." Now who is this devil? Can we be at a loss to know, when we have from just as good authority, that, "A man is tempted by the devil when he is led by his own passions and lusts."

3. Where can we meet this arm of destruction? We can meet it at table telling us to eat more than our system requires; we can meet it at any time or place telling us to make undue exertion to attend a party of pleasure, when conscience tells us to remain at home; we can meet it in the market telling us to purchase something, which we cannot afford, and without which we are comfortable; we can meet it insinuating that, if we had better clothes, if we had more money, we could possess advantages, of which we are now deprived, thus endeavoring to stimulate us to make extra exertion to possess money, and giving to us a love for it, which may prove an enduring root of evil; we may meet it telling us to envy those, who possess some mental or physical power, with which we are not endowed; and this last seems, really, to be the most unreasonable thing, into which this mischievous arm ever endeavors to lure us; because, if we do well, the same blessings are open to us as well as to others; the laws of God show no respect of persons; why should I envy a person his physical strength, when I know that if I throw my exertions in that direction, I can soon pass all that I wish; or why should I envy him

intellectual attainments, when I know that if I set my mind to work, I can in time, acquire all that I desire? In short, we can meet this arm of mischief in any place where we are inclined to do, or to leave undone those things which judgment and conscience tells us is wrong to do or to neglect,

4. How can we know it? "We can know it by its unwillingness to acknowledge that Jesus Cerist is come in the flesh." That is, it is unwilling to admit that the spirit of Christ abides within us, and that when we violate the laws which govern the health of our bodies, we sin against Him, and drive his spirit from us.

5. How shall we defend ourselves against this evil *arm?* By keeping a sentinel always on guard to watch its movements, and give intelligence of its points of attack; by unceasing desire to escape the dangers into which this evil arm is ever endeavoring to draw us; by giving the supreme affections of our hearts to God; by trusting his willingness to bless us; by studying His laws, that we may understand his capacity to do more for us than we can ask, more than we know that we need.

6. In all ages of the world, we have examples of persons, who have been able, under great loss of friends; under great mental and physical suffering, to maintain a calm state of mind, evidently showing that this state of spiritual existence, is not owing entirely to external circumstances; but that it is due, in the main, to a pre-organized condition of the nervous system, and the establishment of the spiritual existence upon that form.

7. Is it desirable to possess a state of mind that will

allow the builder of this house, when it is out of order to repair it by setting the absorbents to work to carry off the mountains of mischief, which have been deposited where they should not have been, and to cast them into the sea of blood, which belongs to our earth, or bodies made of earth. If we do, we must believe that God has power to make these repairs; and we must believe that He is willing to do it; we must be contented to wait his time to do it, instead of setting to work, and by our impatience tearing down faster than he can build.

8. Many an inebriate would be reformed, many who lead lives of vice, that end in destruction of both body and soul, would be reformed, did they but know that if they refrained from these vices, and watched against the temptations to perpetuate the evils that the spirit of God within them, which first built this house, has power to repair it in the most perfect manner in all its primitive perfection, and even more, to place them beyond the power of temptation.

9. How important that youth should be raised in the nurture and admonition of the Lord, and how important that they understand the application of those admonitions, that they may be able in time, to obtain a zeal of God, which shall be according to knowledge, and which shall be efficient in pulling down the strong holds of iniquity within themselves.

10. While this work has been in press, I have noticed an article in the New York Sun, saying that it could not be capilliary attraction which carries the fluids up in vegetation, because severing vines sometimes kills them by overflowing; and that gravitation does not bring the fluids from drooping branches. The princi-

ple of the artesian well will account for the first; and the principle of the siphon will account for the second of these phenomena.

11. From certain newspaper discussions, at the present time taking place, I deem it advisable to append a few remarks, lest some things that have been necessary for me to say in this work, should be misconstrued. And first, I will make the statement that I am an implicit believer in the scriptures as the revealed will of God, through inspiration of His servants. Second; that I fully believe these revelations to have been made in accordance with the laws established by God for the government of His creatures, and to be made known for the express purpose of delivering them from sin, and consequently from the evils which it involves, and which are inseparably linked with the violation of holy law. Third; that in saying, "If evil spirits could exist after dissolution of the body," I did not mean to insinuate that the bible teaches that they can exist, or that they cannot; but simply to leave the subject where God has left it with me, for He has given to me, outside His revealed word, no instructions on the subject; and of course, I could not assert in my own name, that which has not been committed to me.

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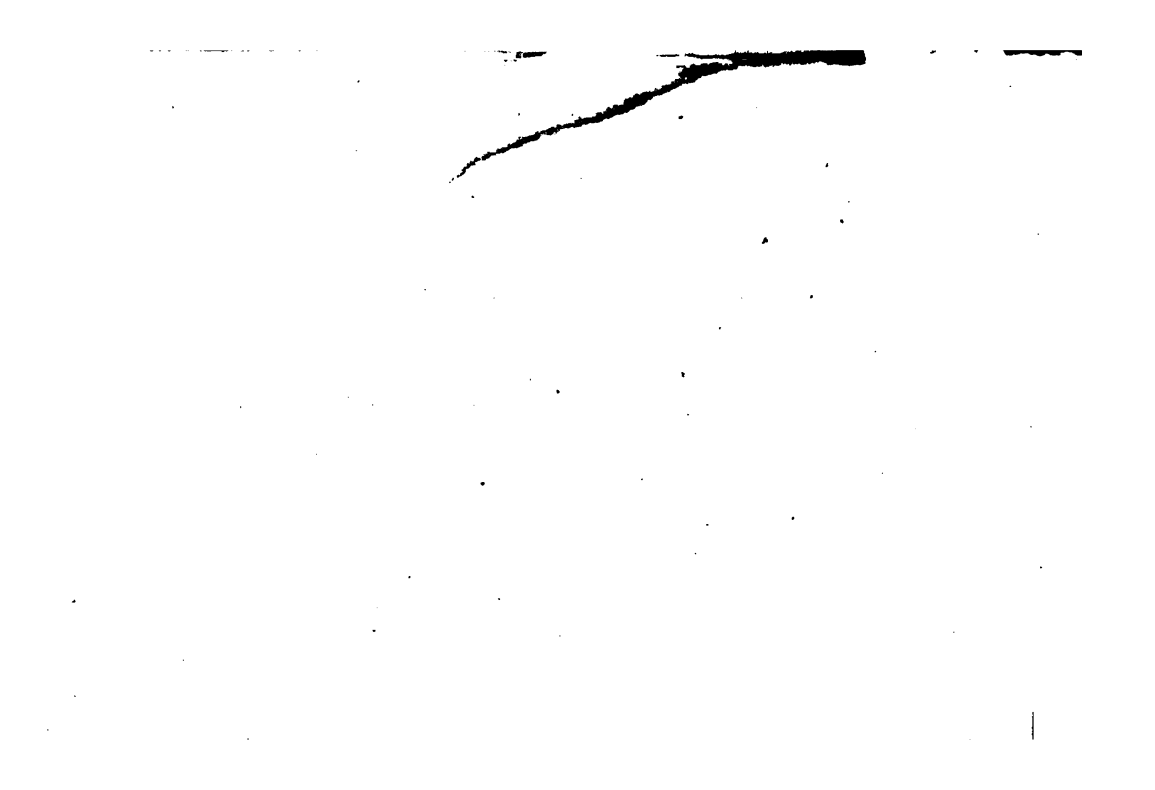

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